THE ENGINEER

NOVEMBER 6, 1959 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

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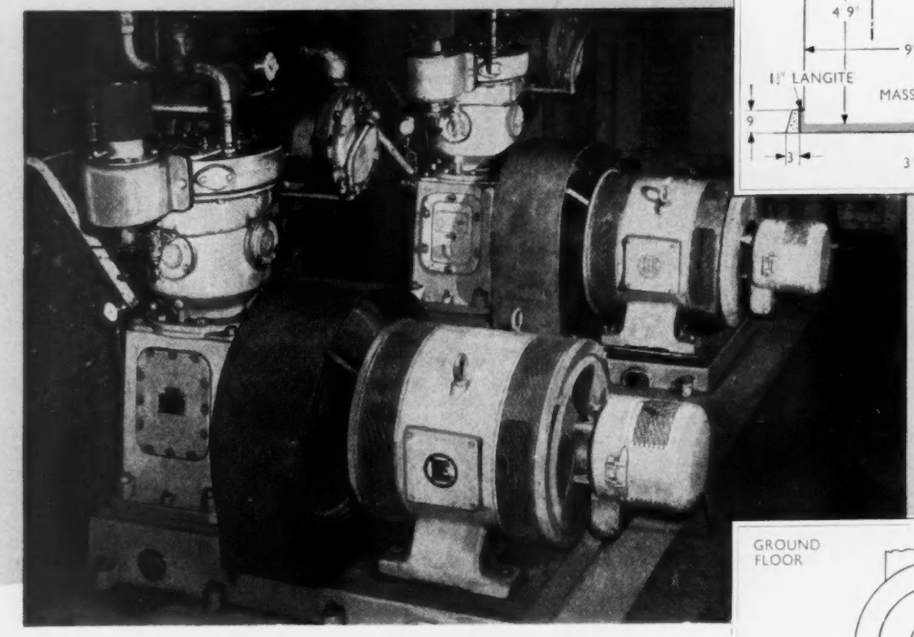
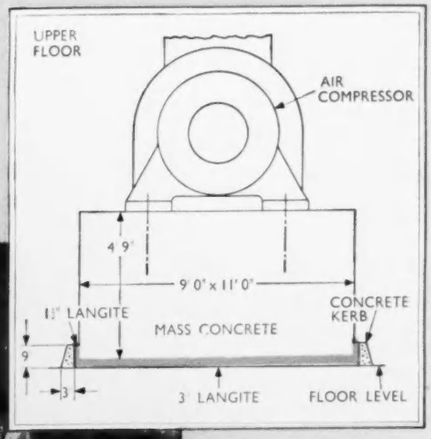
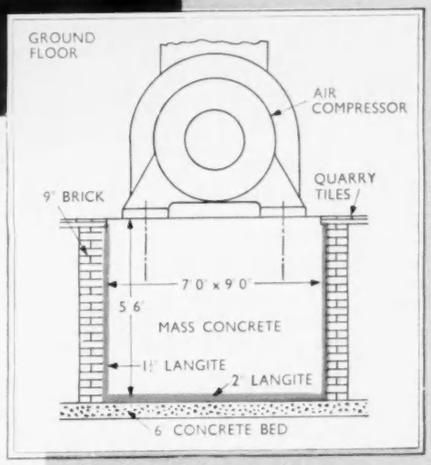




Two compressors are on the ground floor and one on an upper floor; the line drawings show the arrangement.



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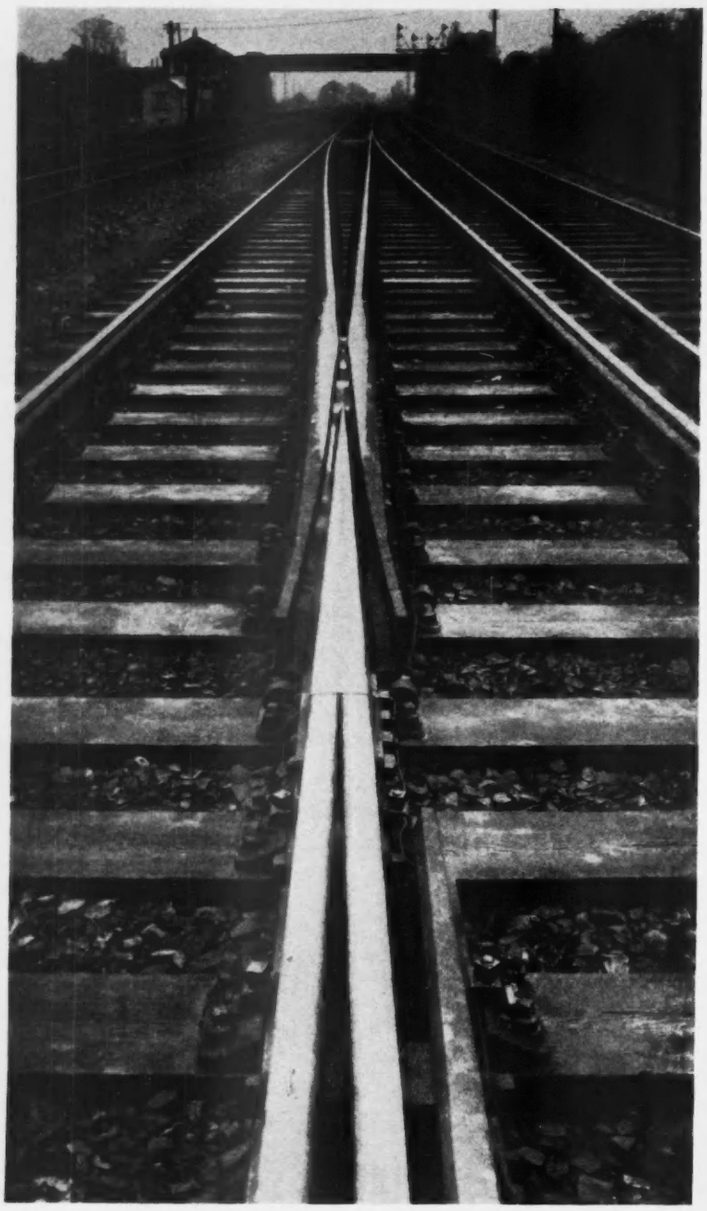

Photograph reproduced by courtesy of British Railways (Southern Region).

The accompanying illustration shows Solid Cast Monoblock Crossings of Hadfields Era High Manganese Steel, in site at Worthing Junction on the Southern Region of British Railways.

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Established 1856

No. 5415 **NOVEMBER 6, 1959** VOL. 208

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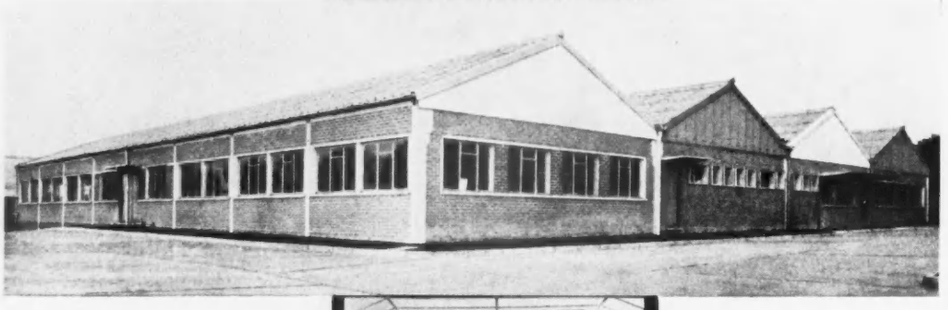

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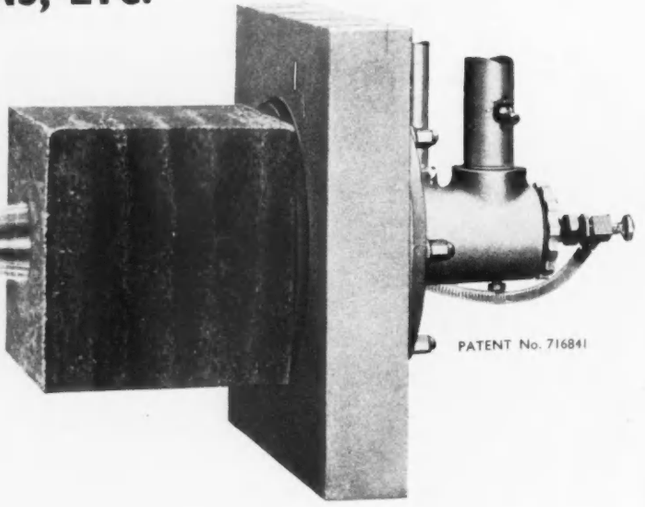

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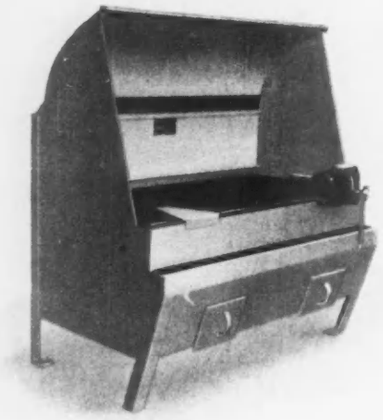

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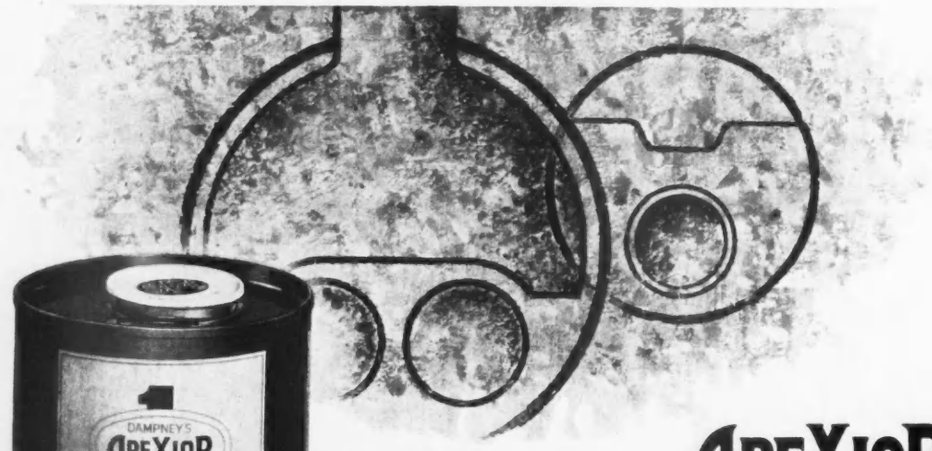

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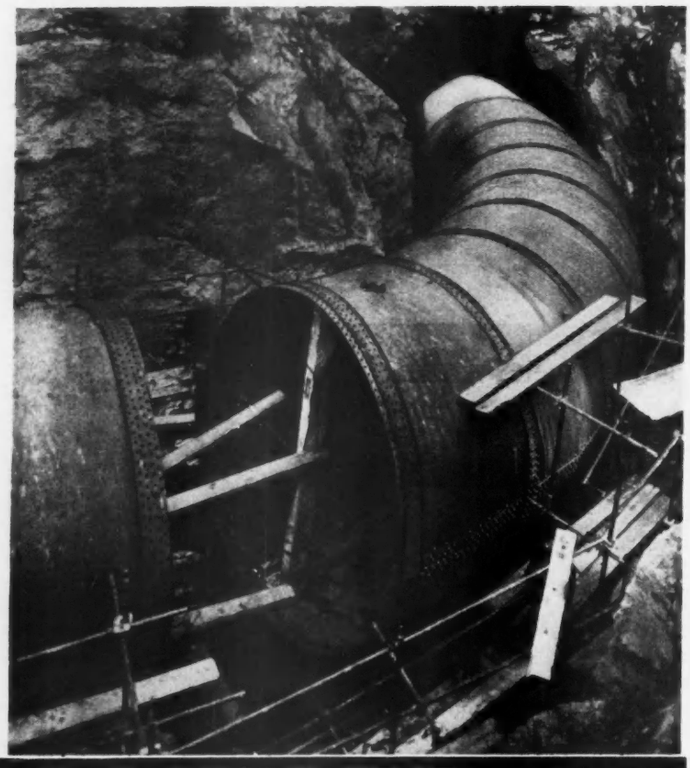

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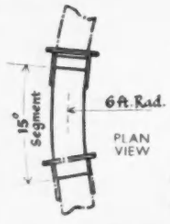

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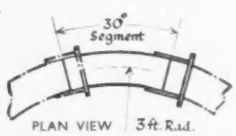

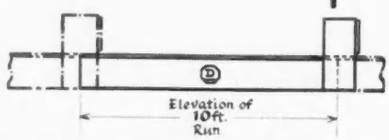

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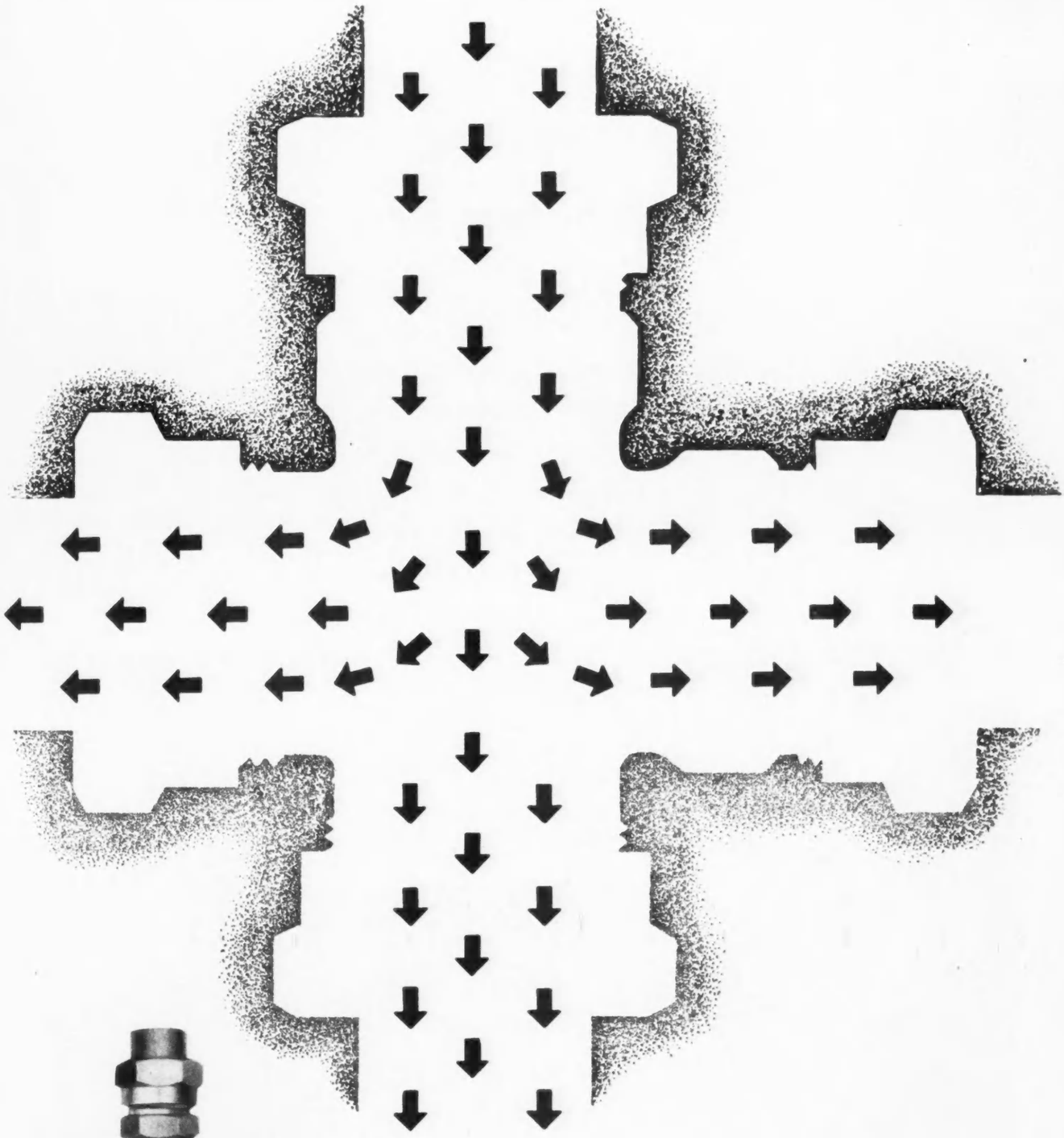

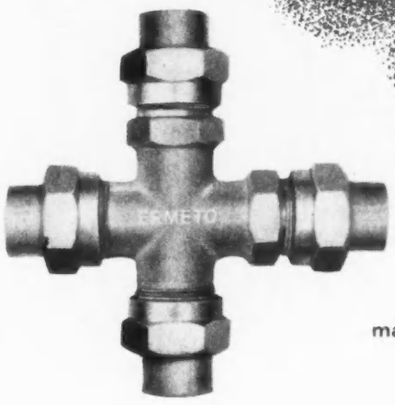

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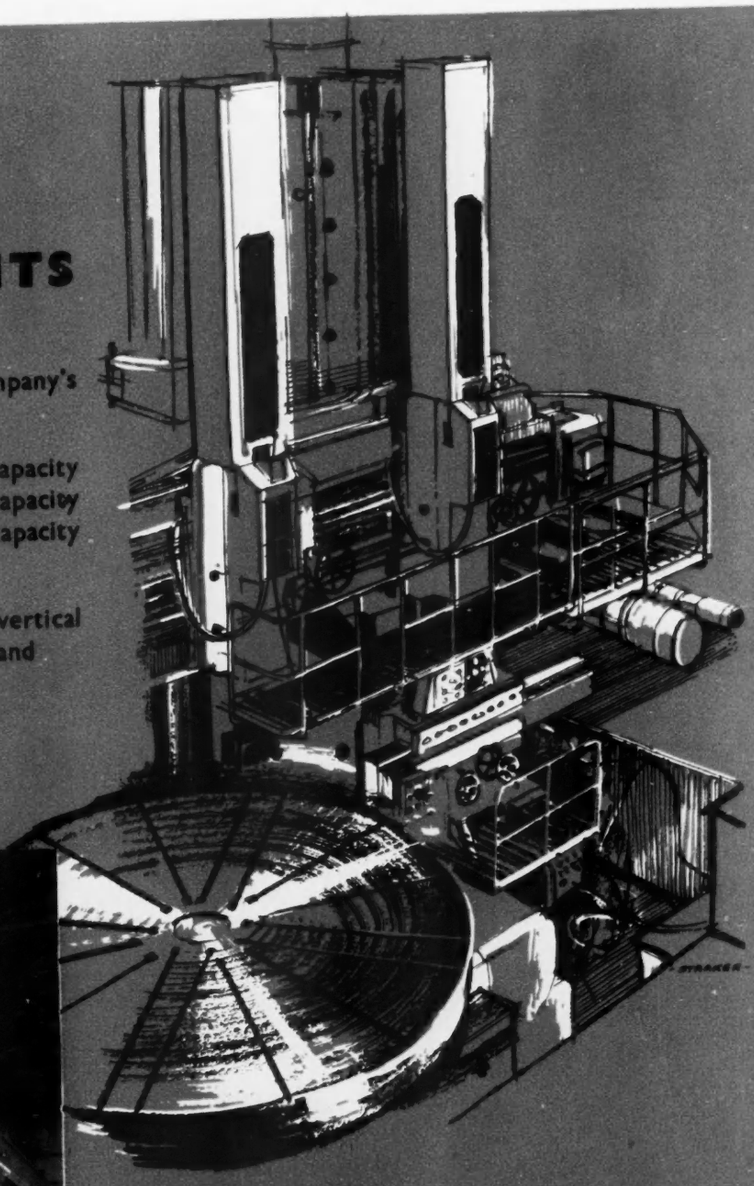

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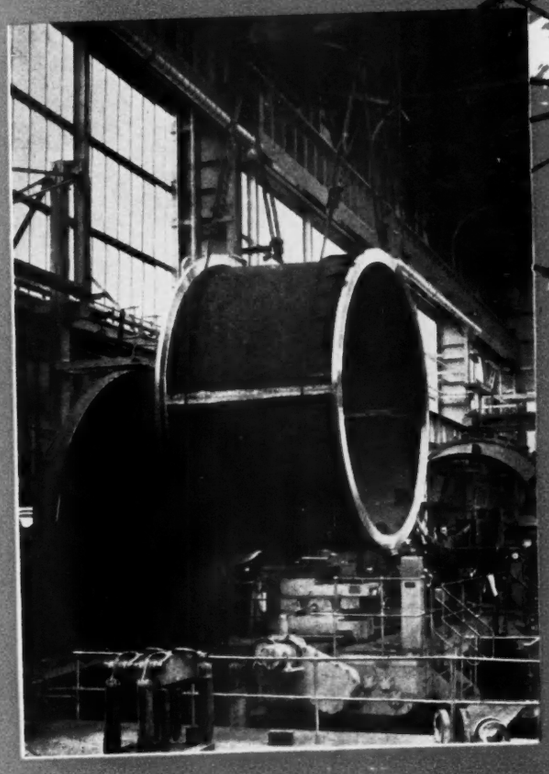

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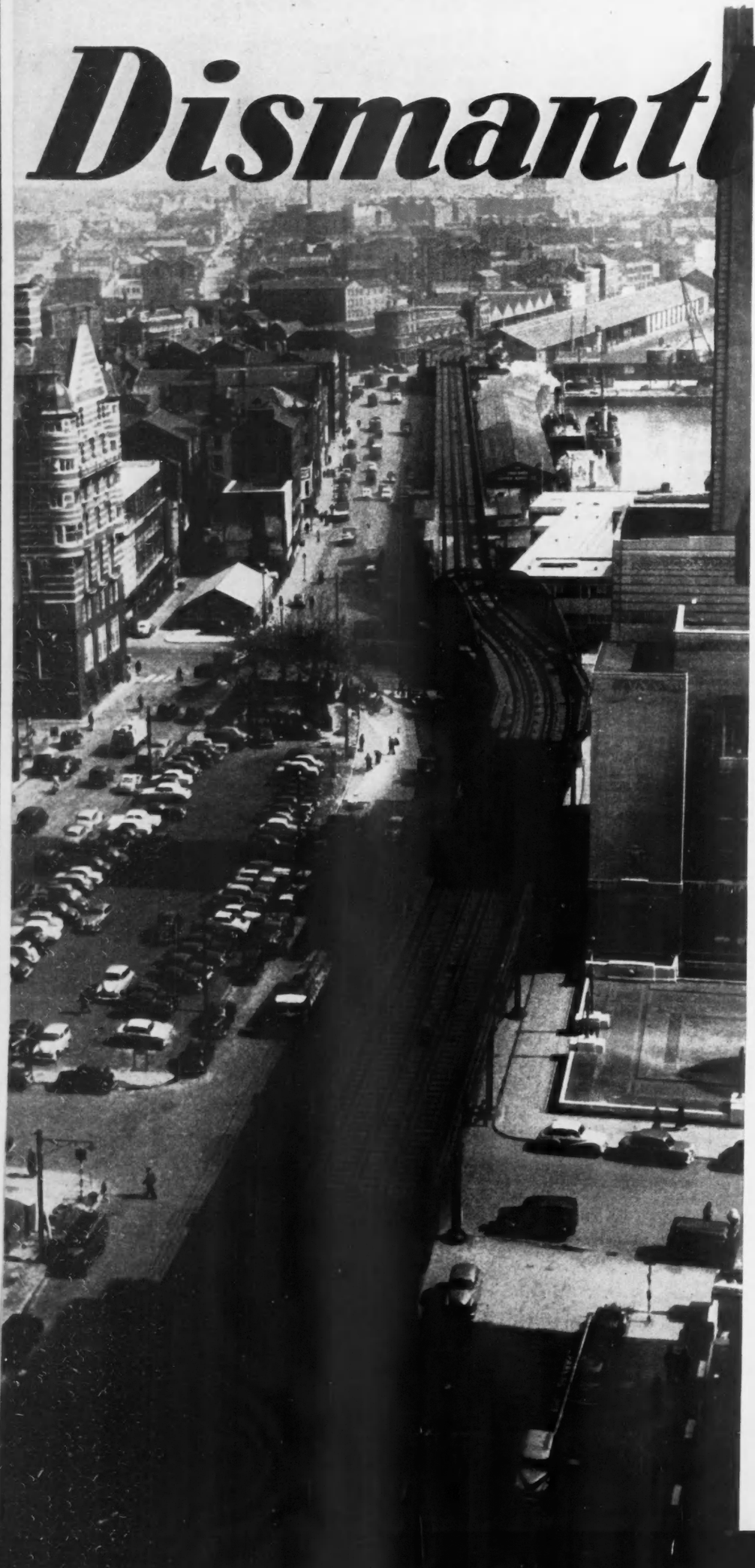

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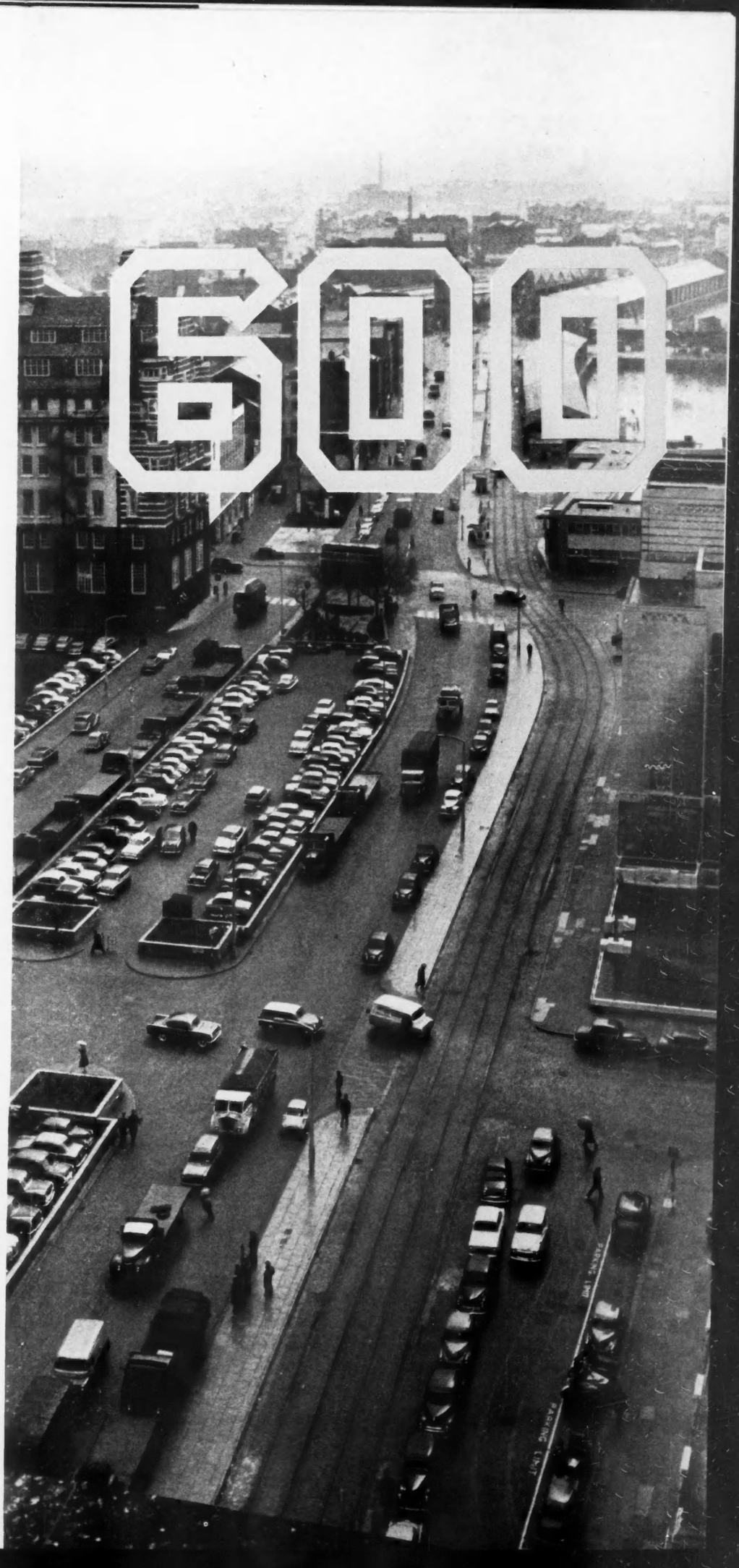

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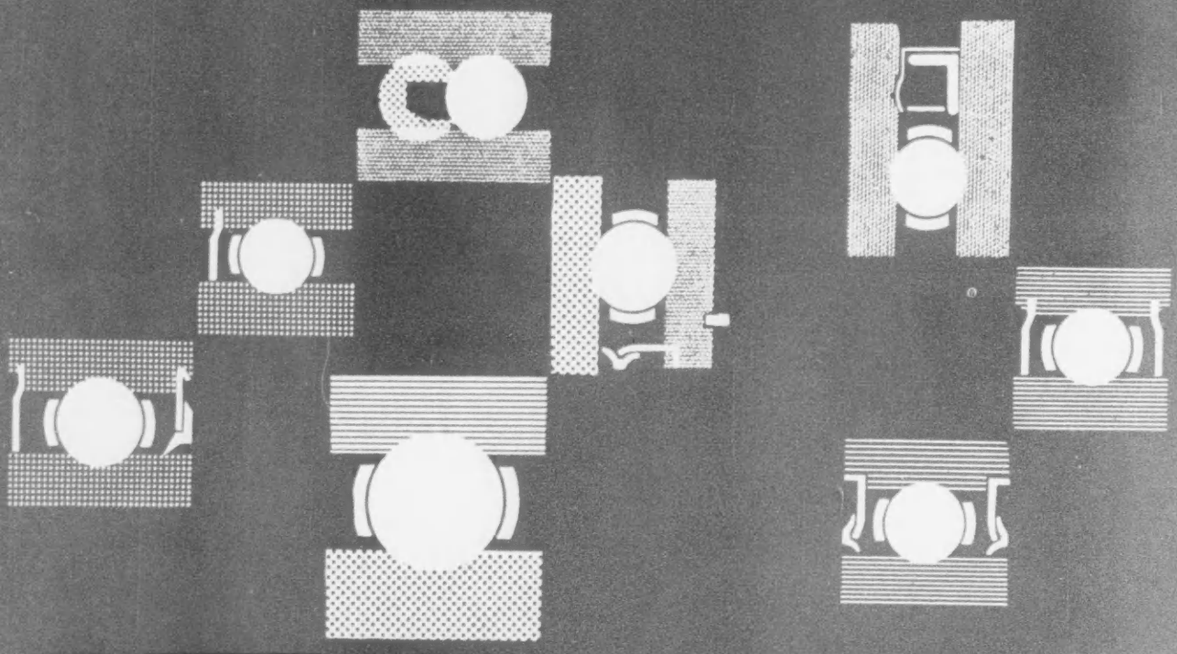

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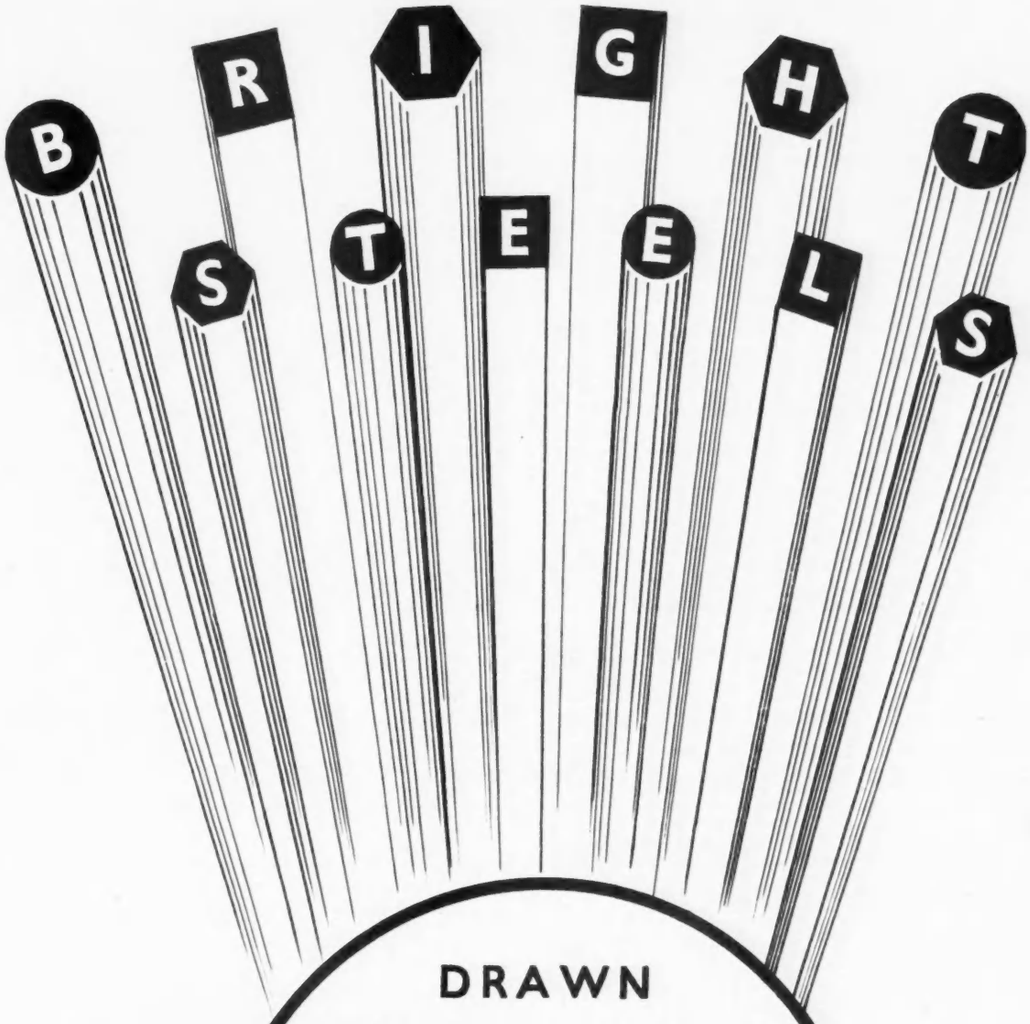

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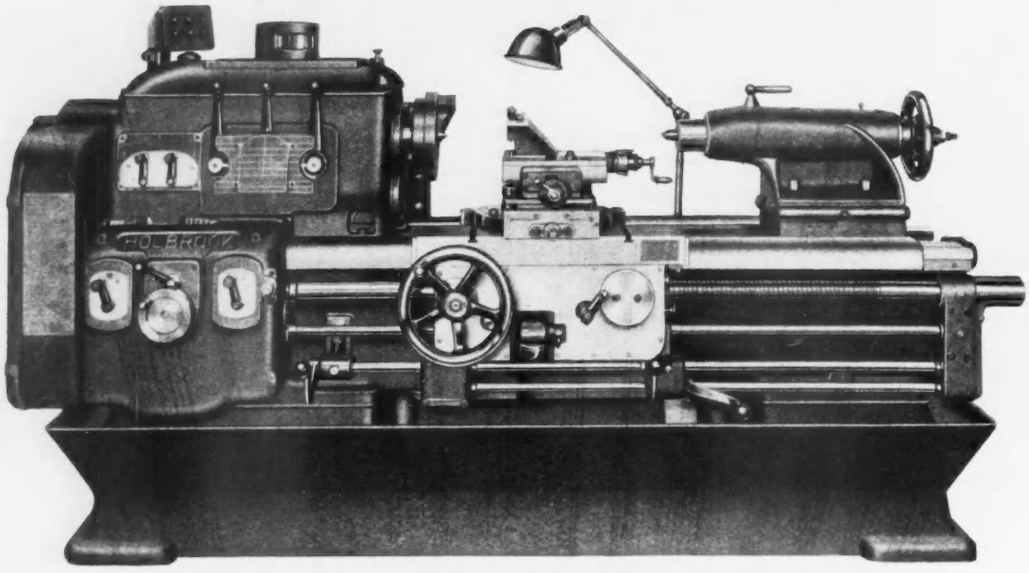

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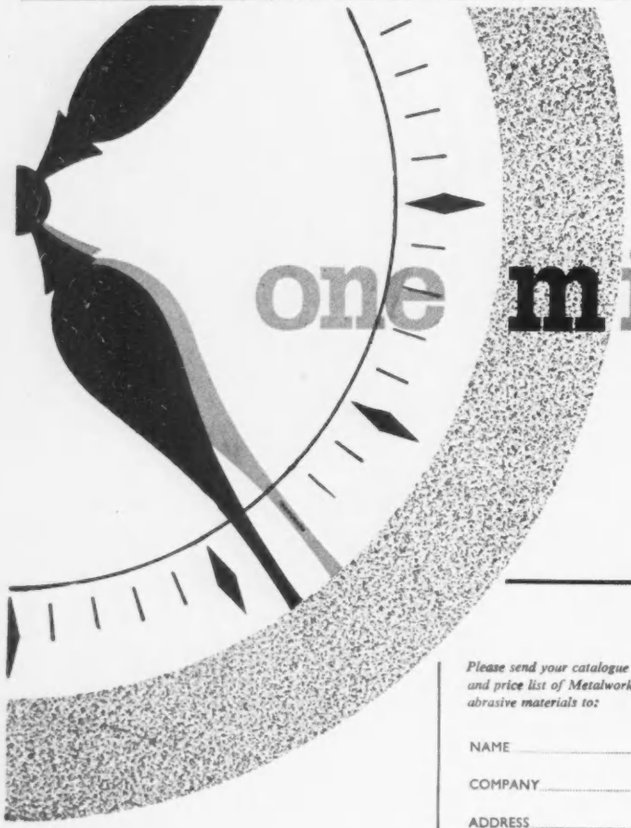

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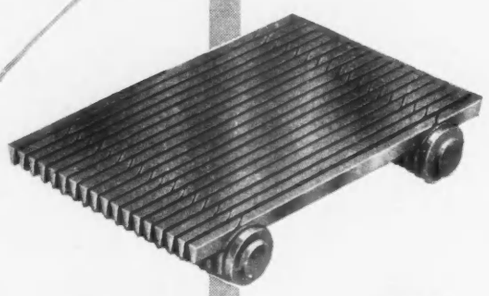

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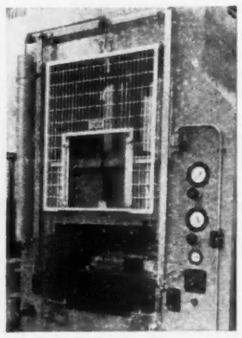

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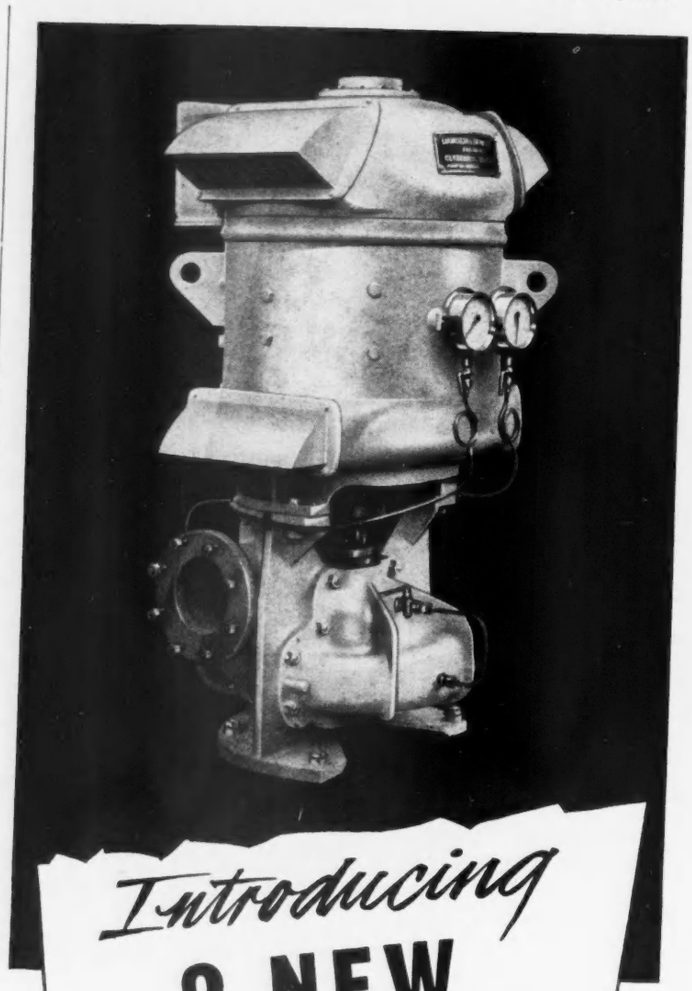

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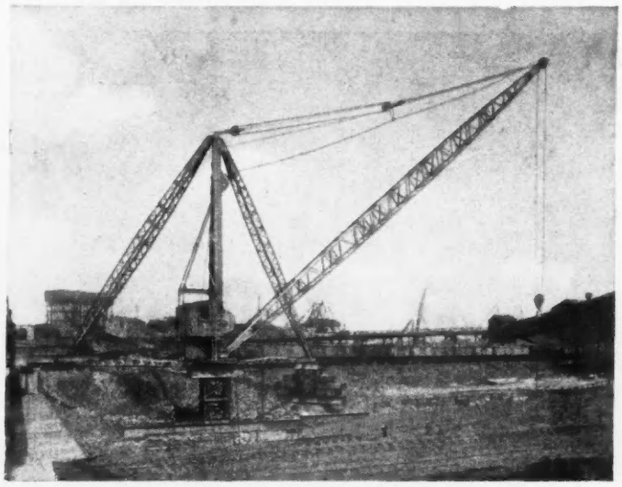

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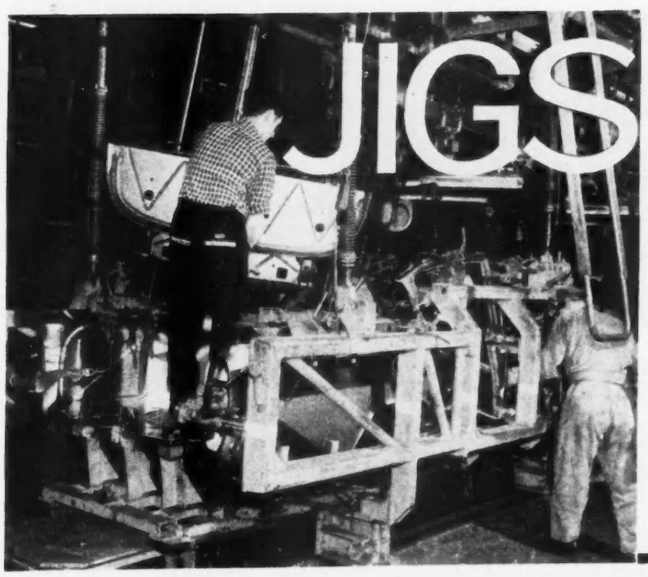

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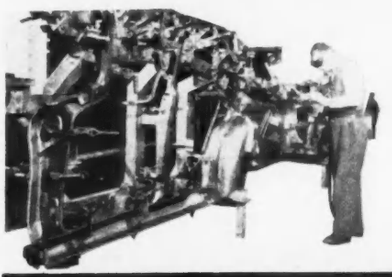

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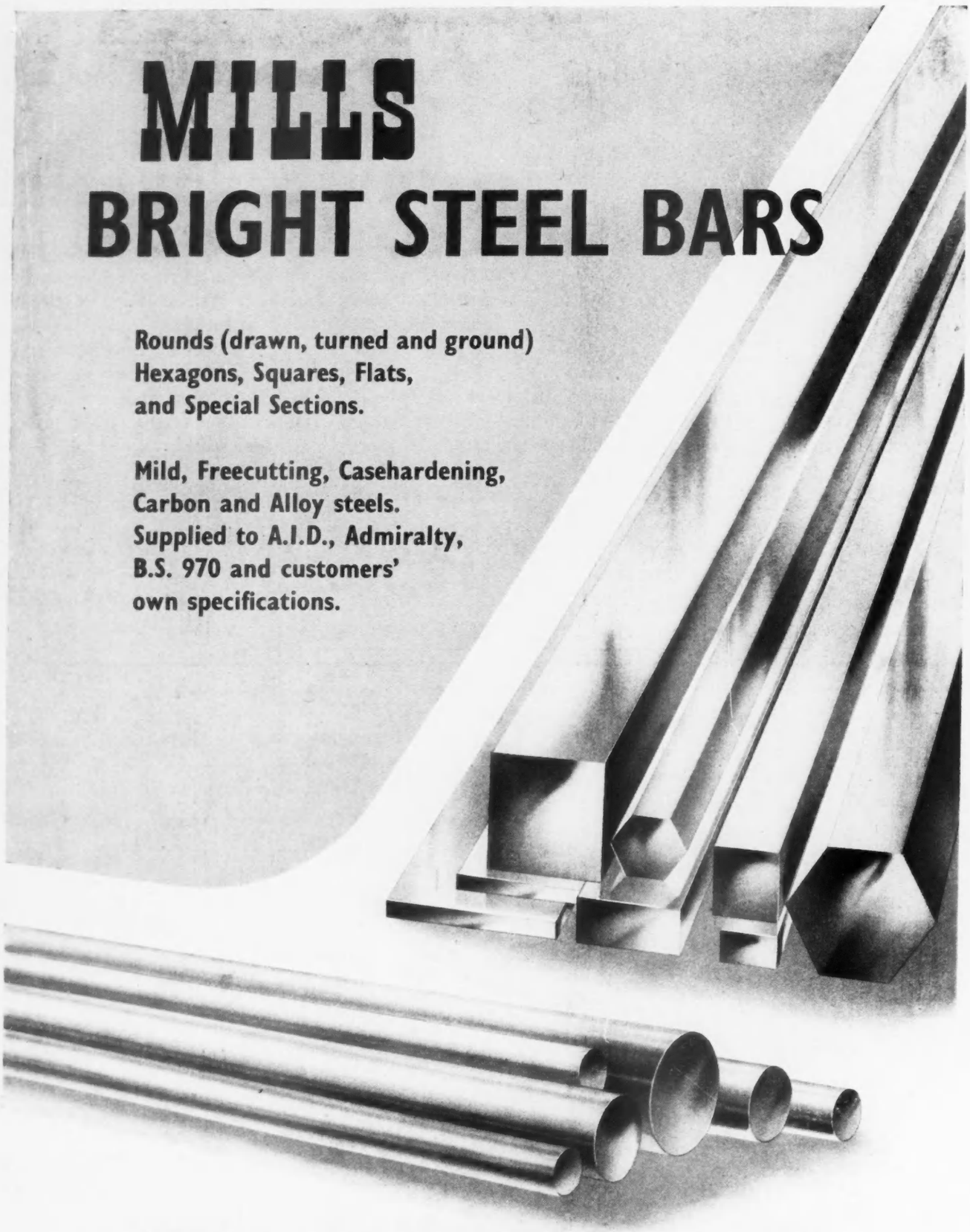

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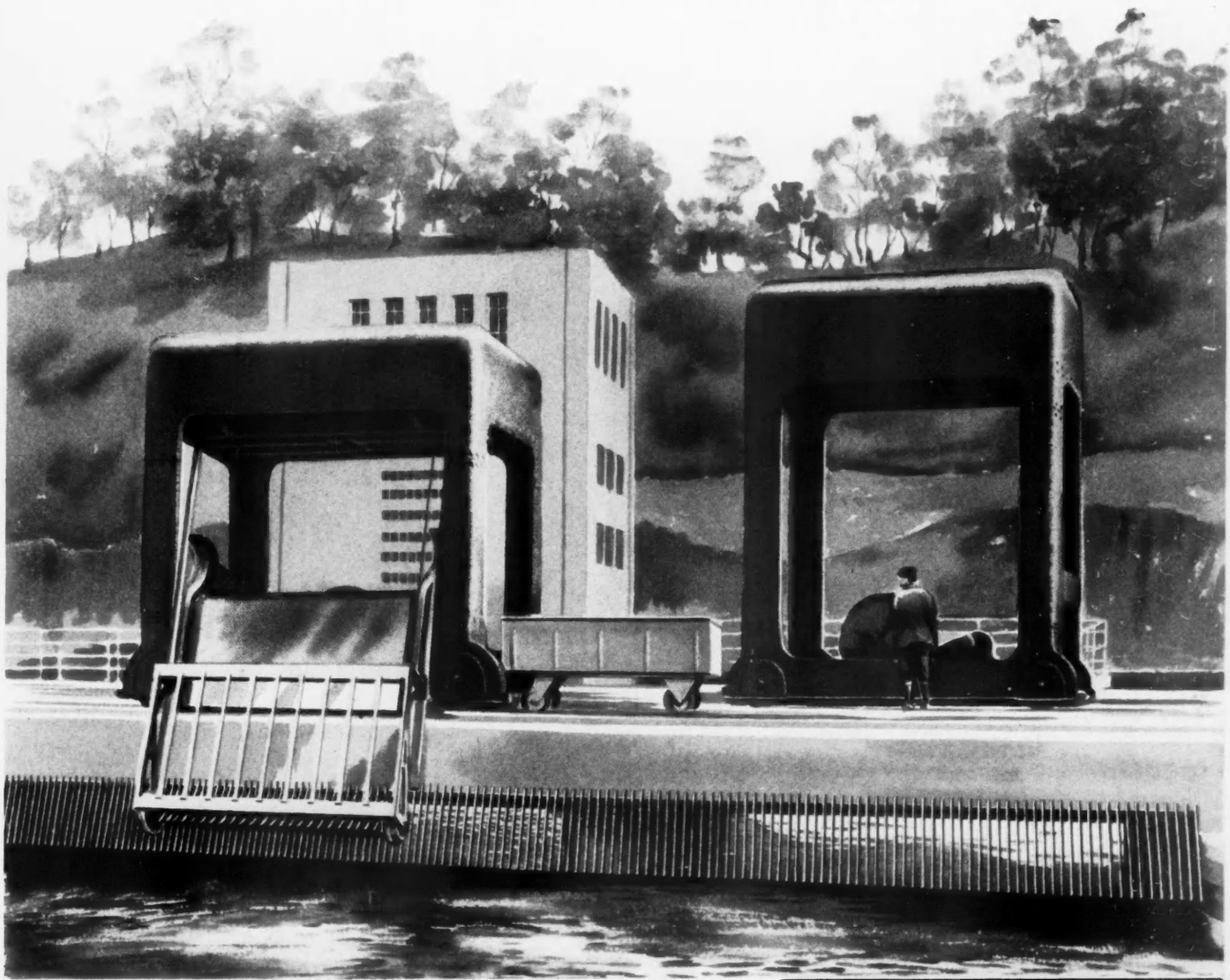

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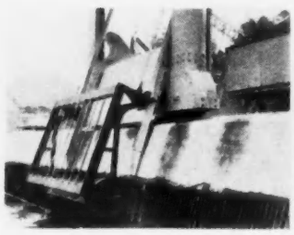

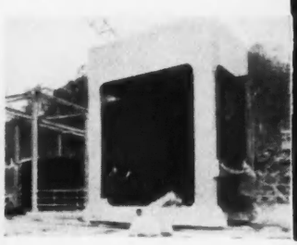

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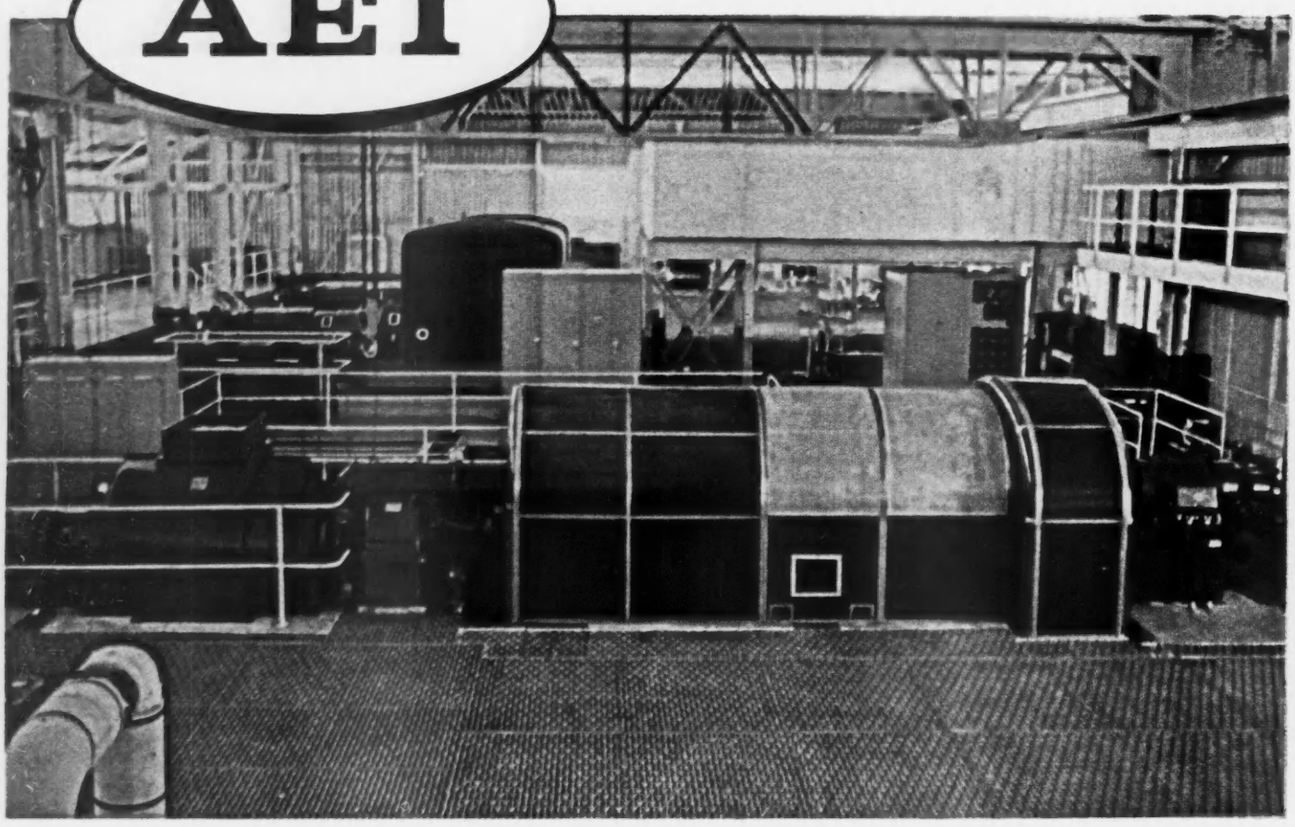

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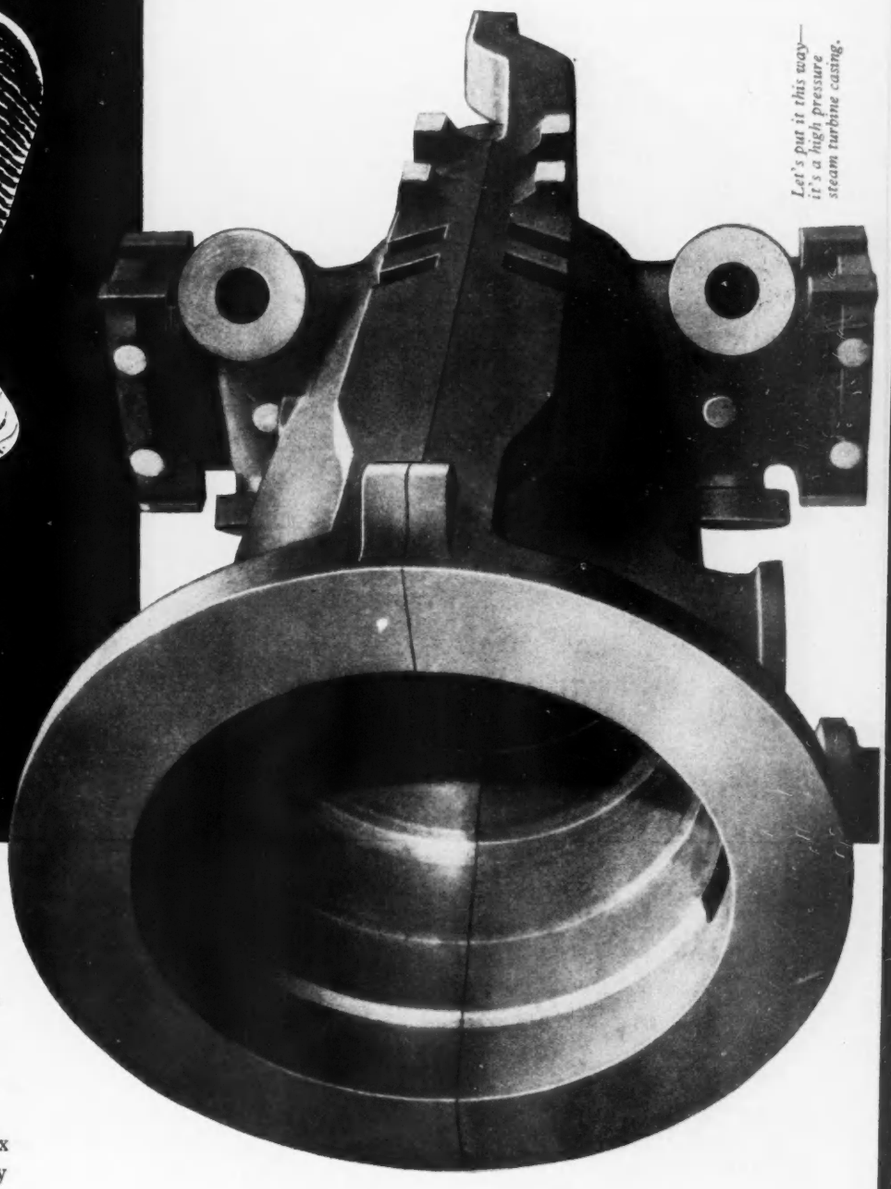

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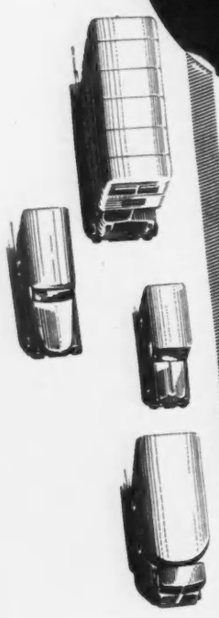

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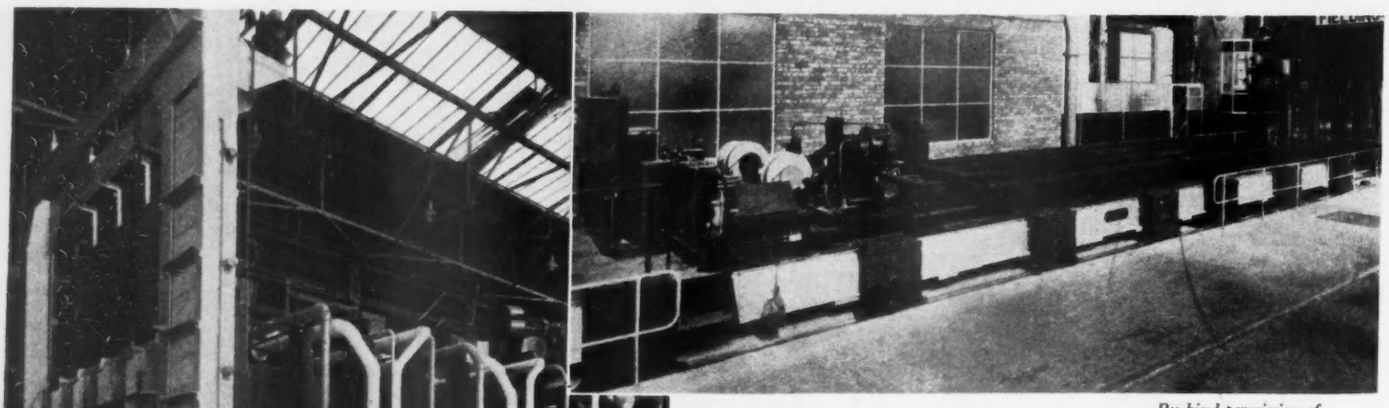

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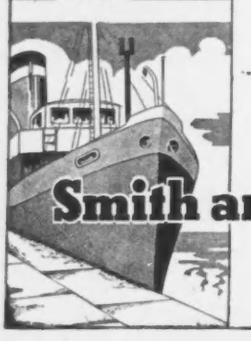

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MF 4301	PU 294	¾" B.S.P.	5 G.P.M.
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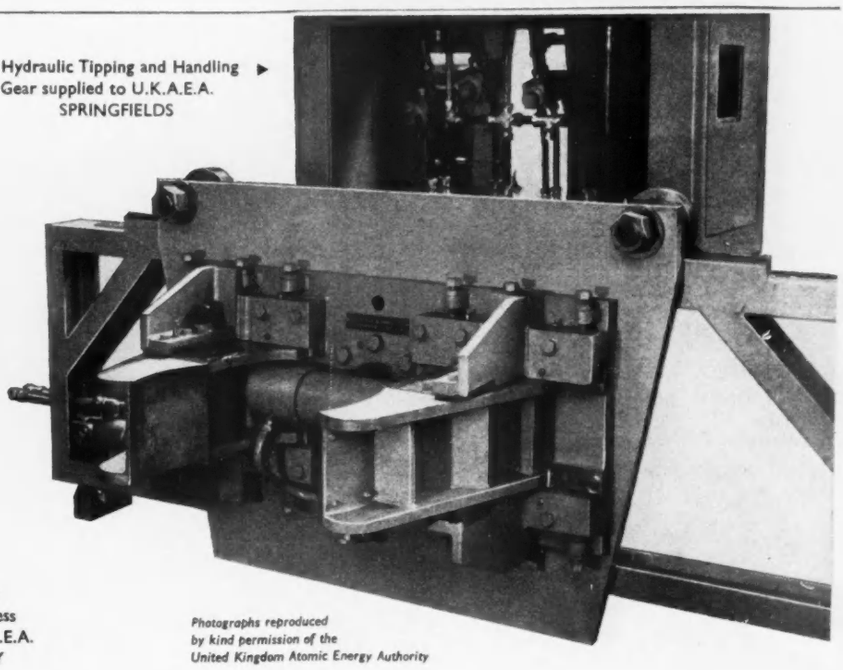

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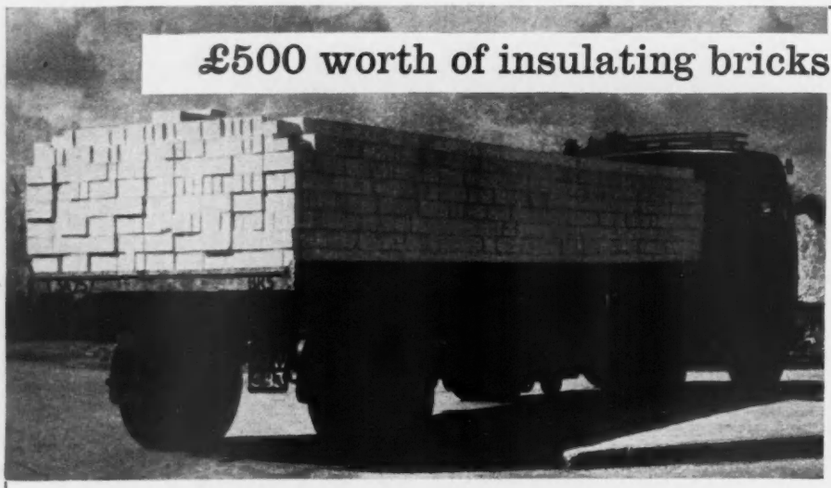

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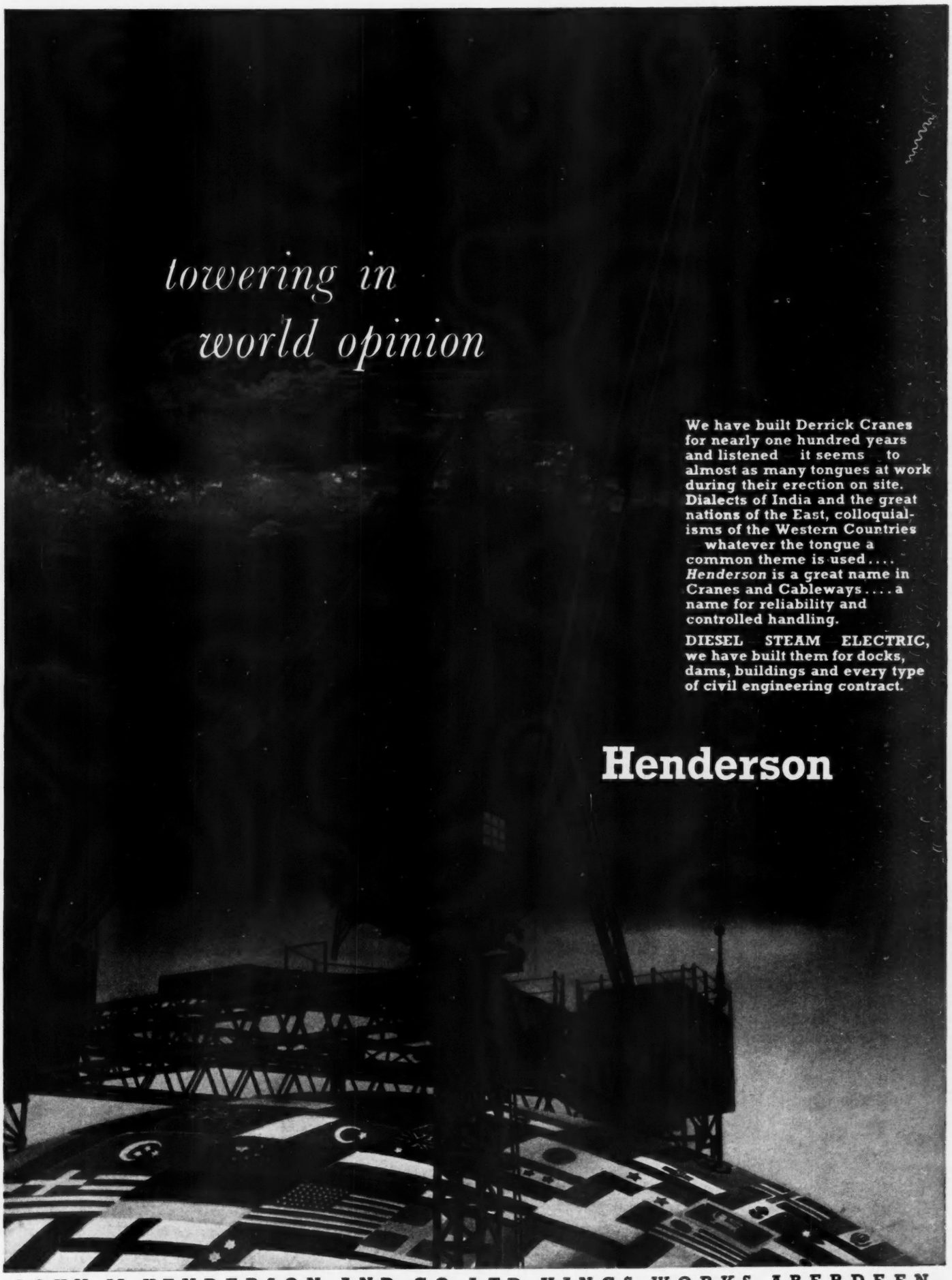
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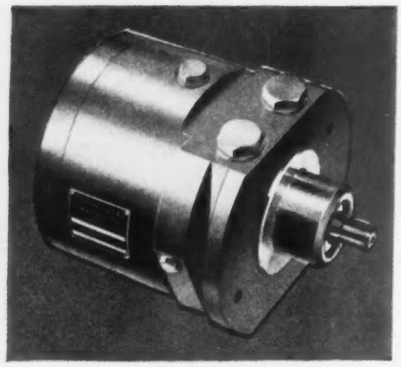

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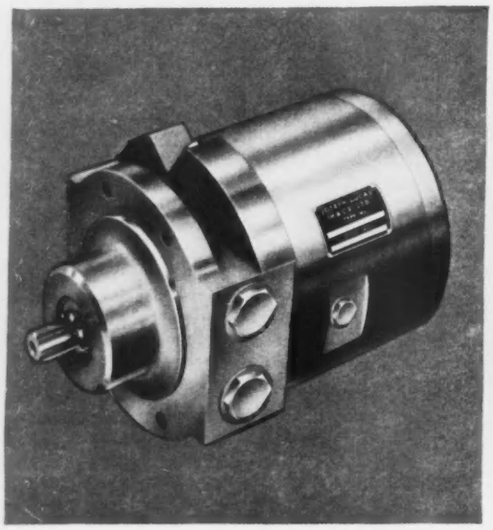

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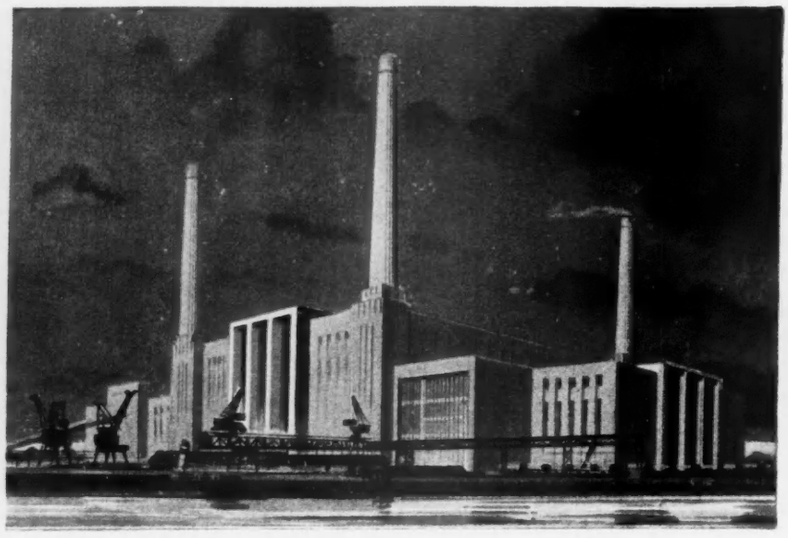

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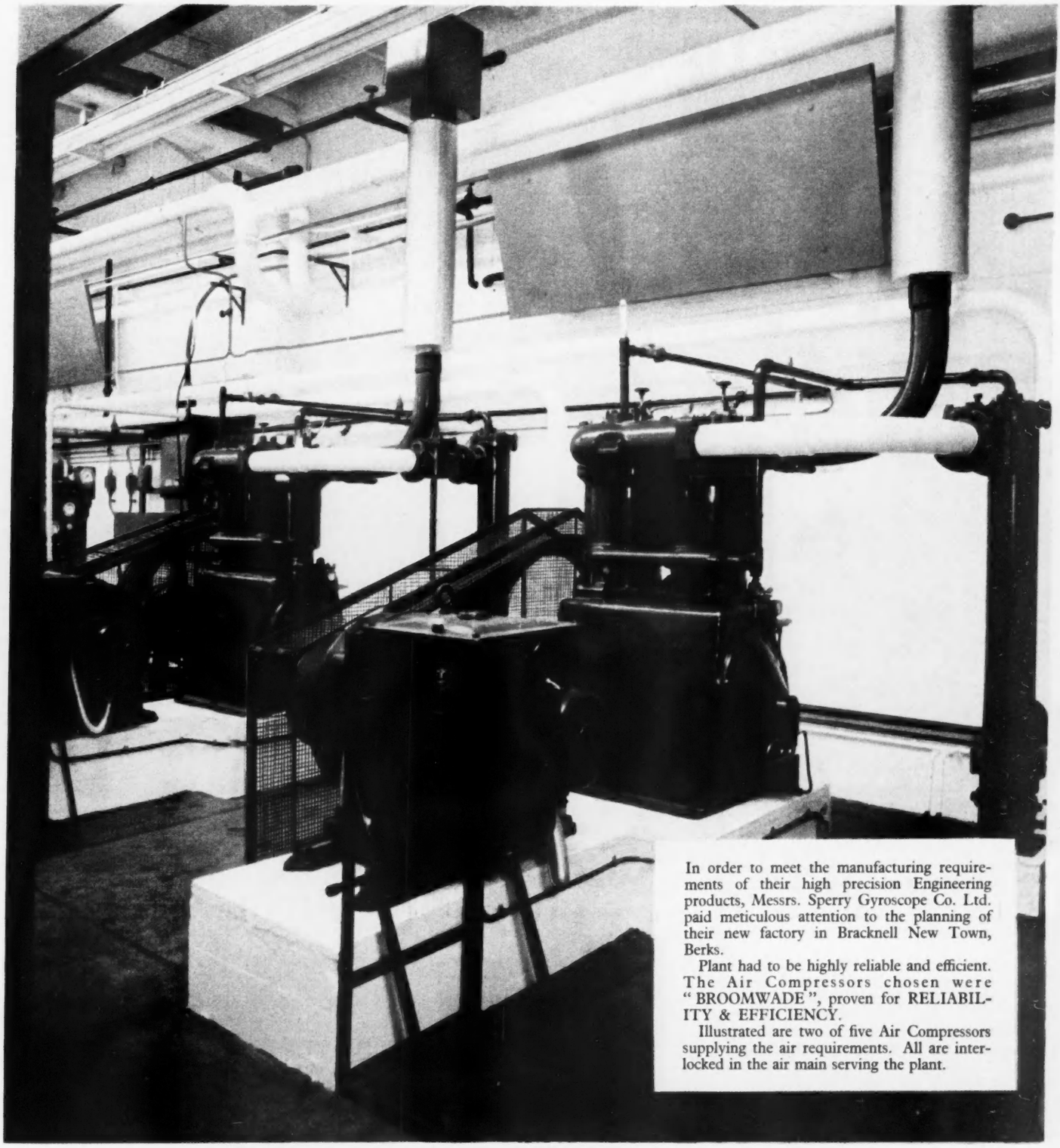

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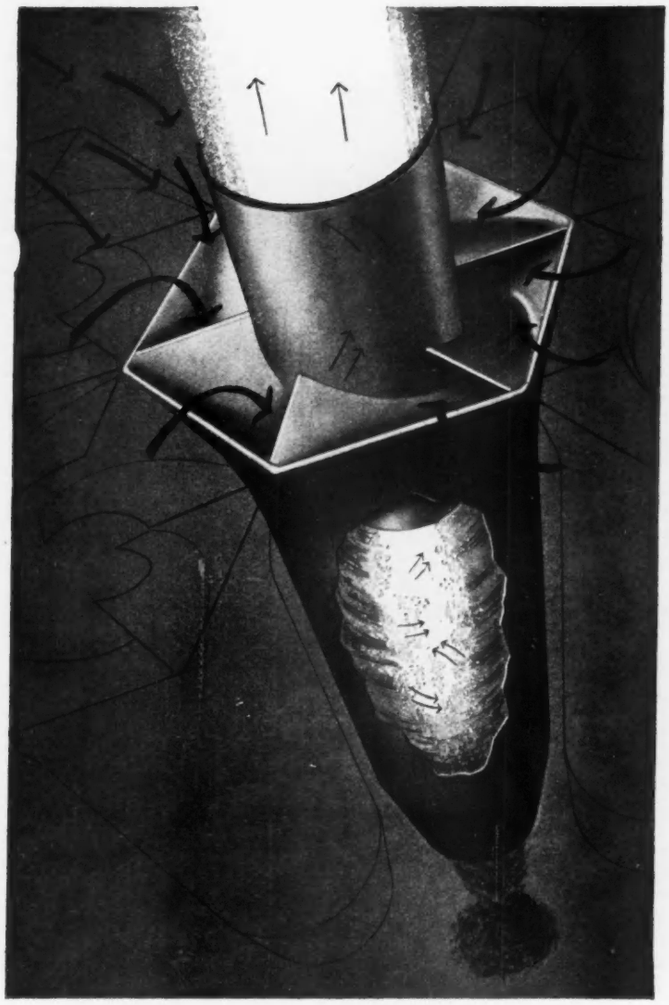

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P PARTICLE
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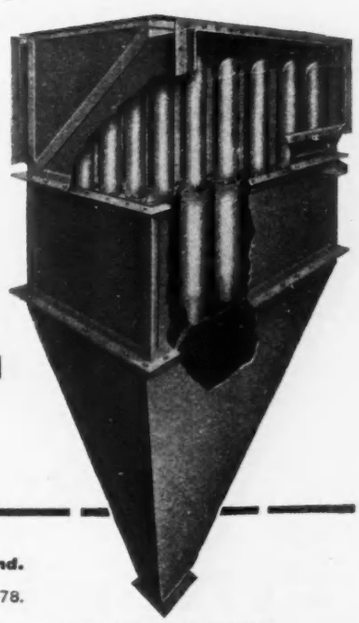

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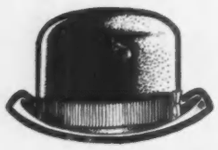
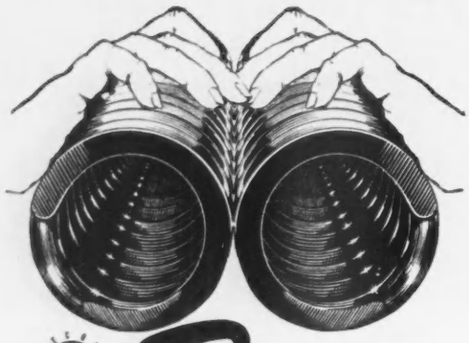


Looking in the right direction



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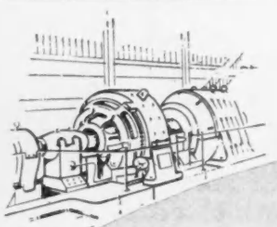
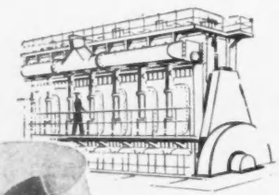
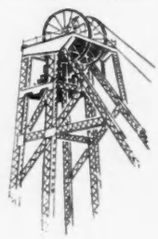

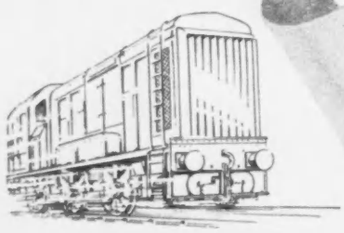

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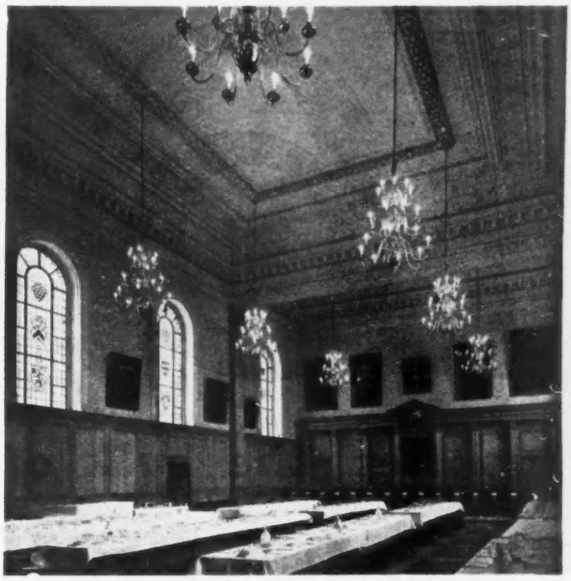

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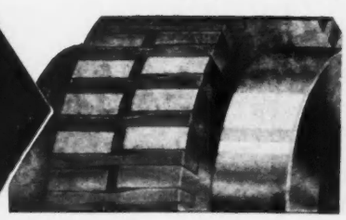

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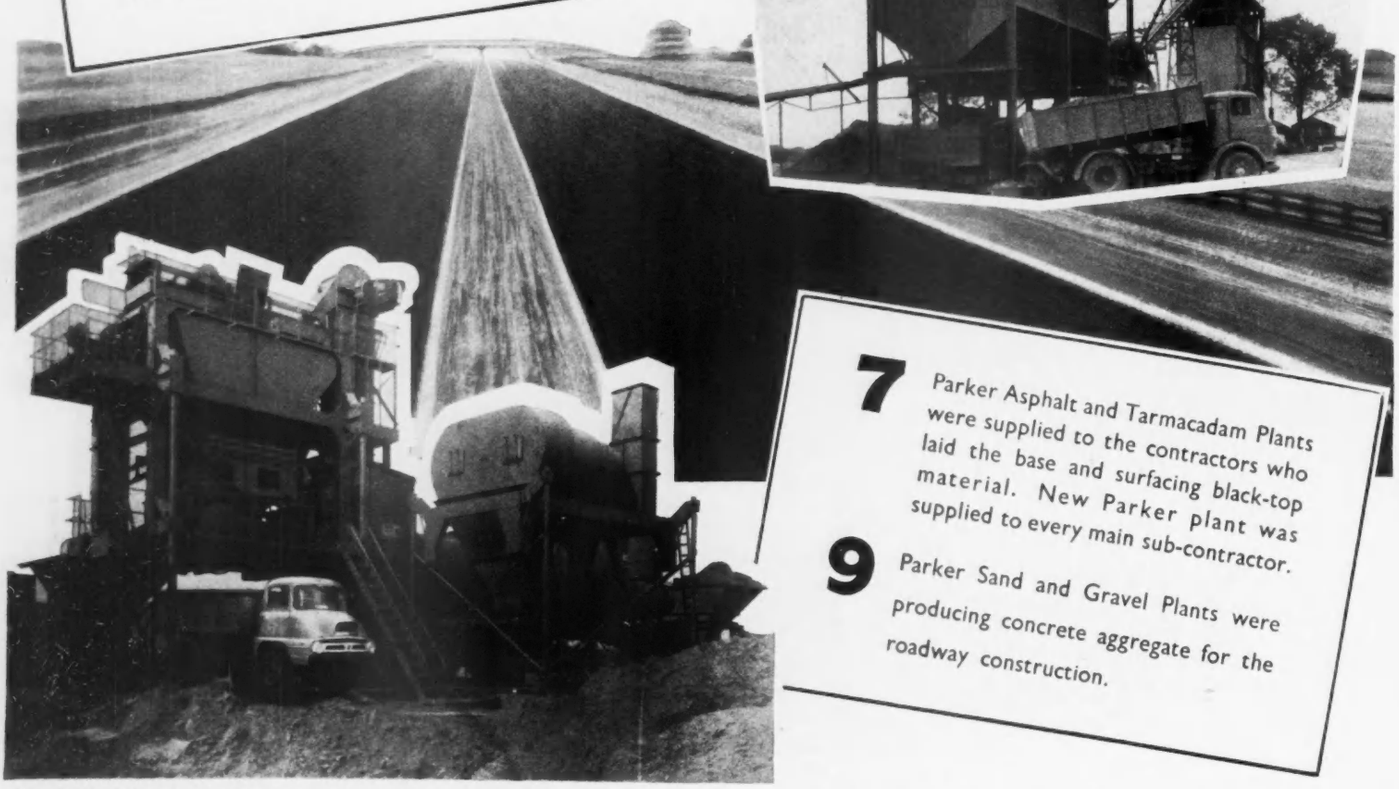

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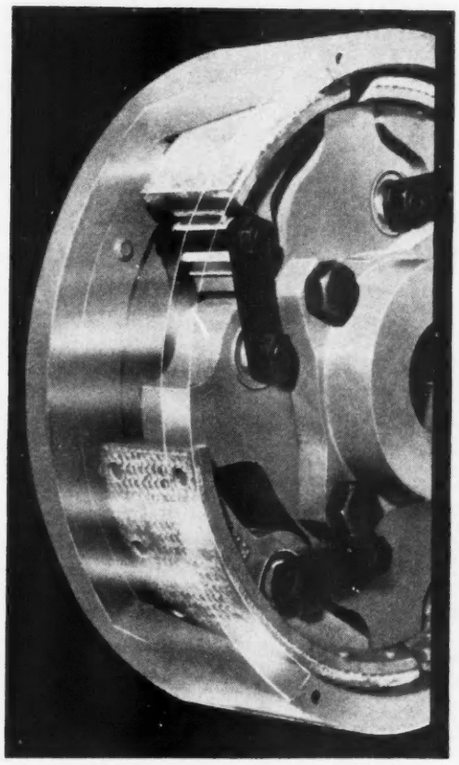

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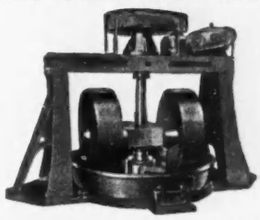

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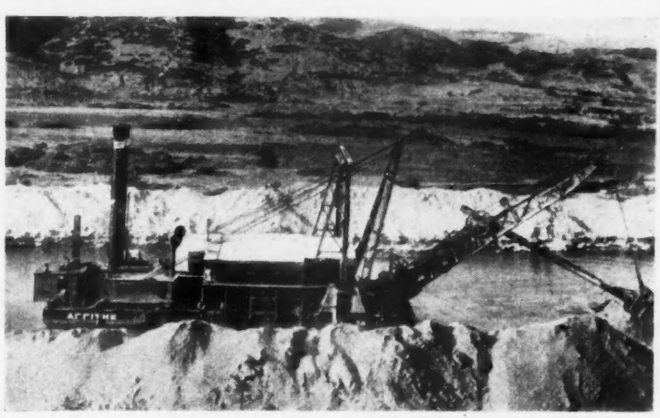

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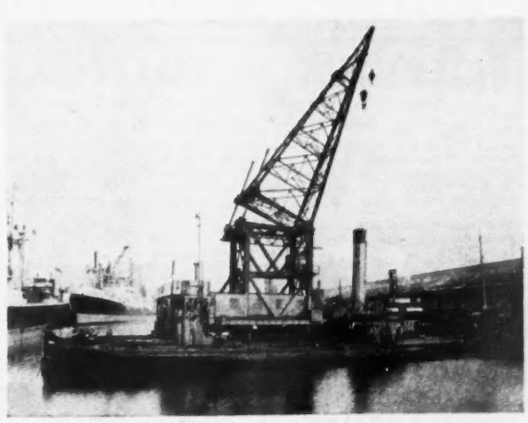

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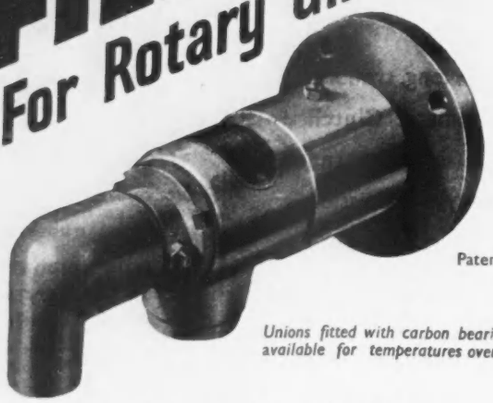

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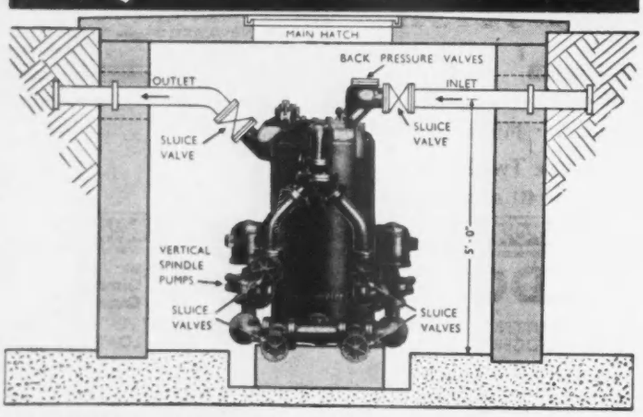

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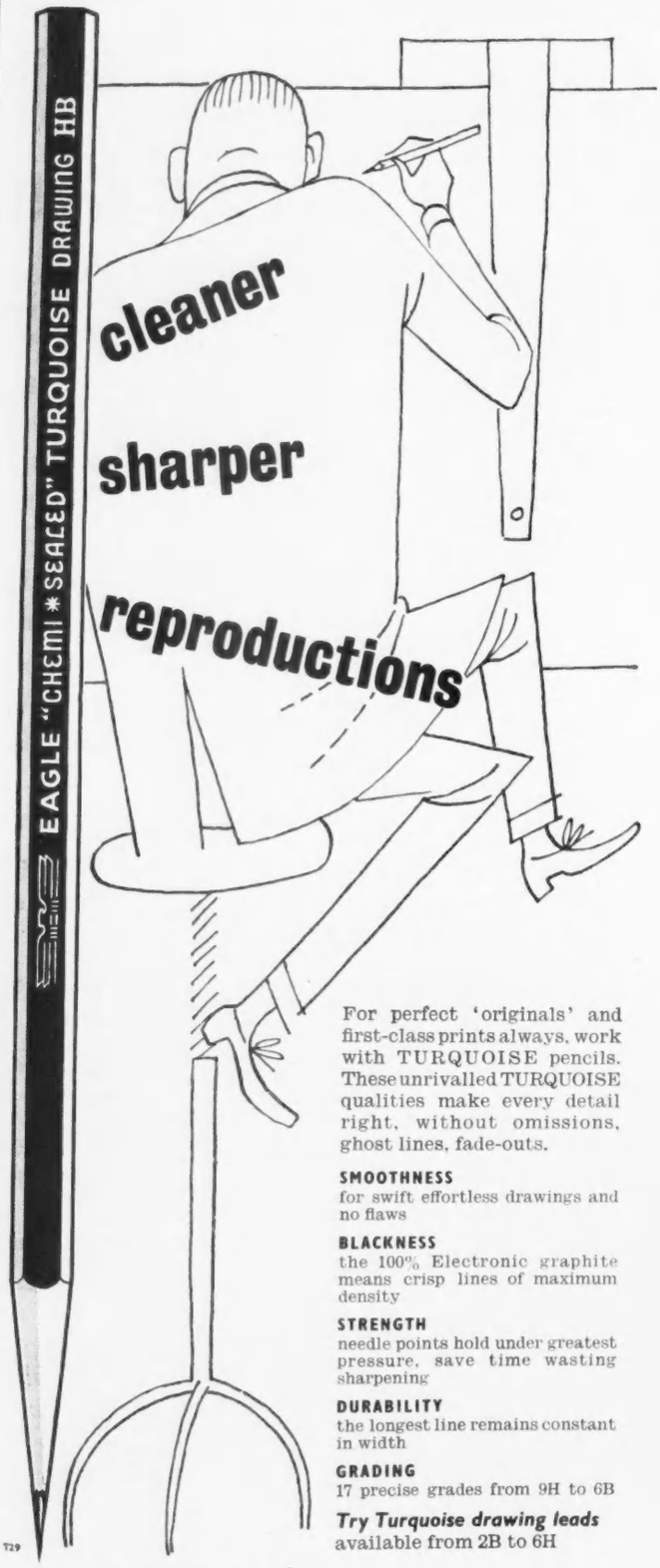

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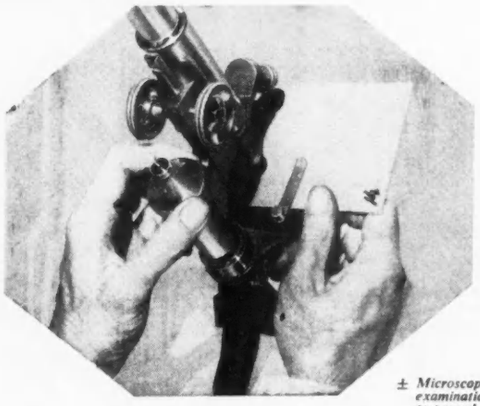

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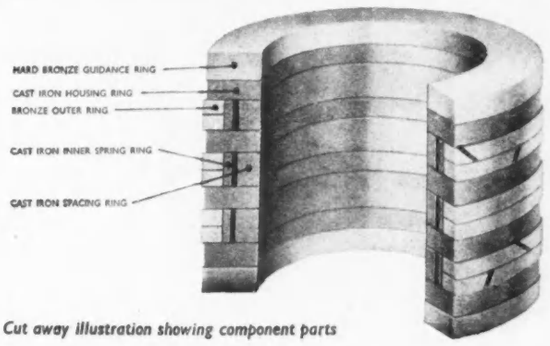

Cut away illustration showing component parts

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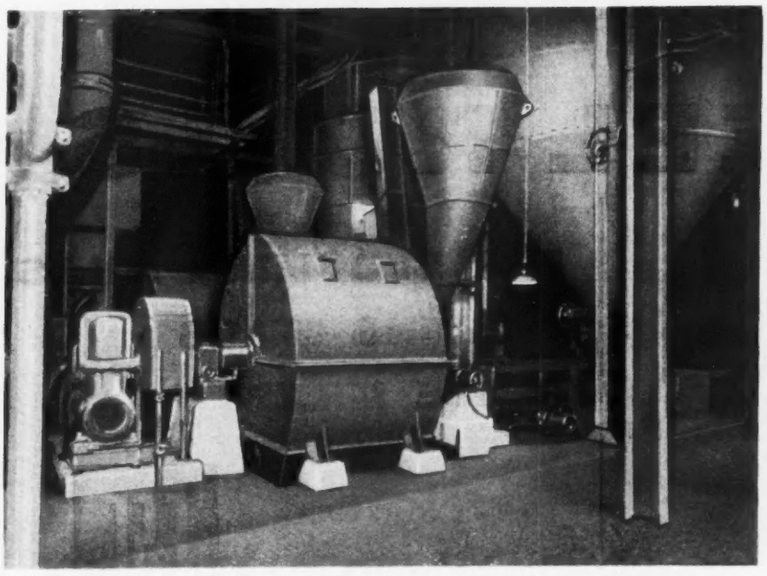

Typical installation of Ball Mill with vacuum system of air separation. Note the direct-coupled gearbox drive.

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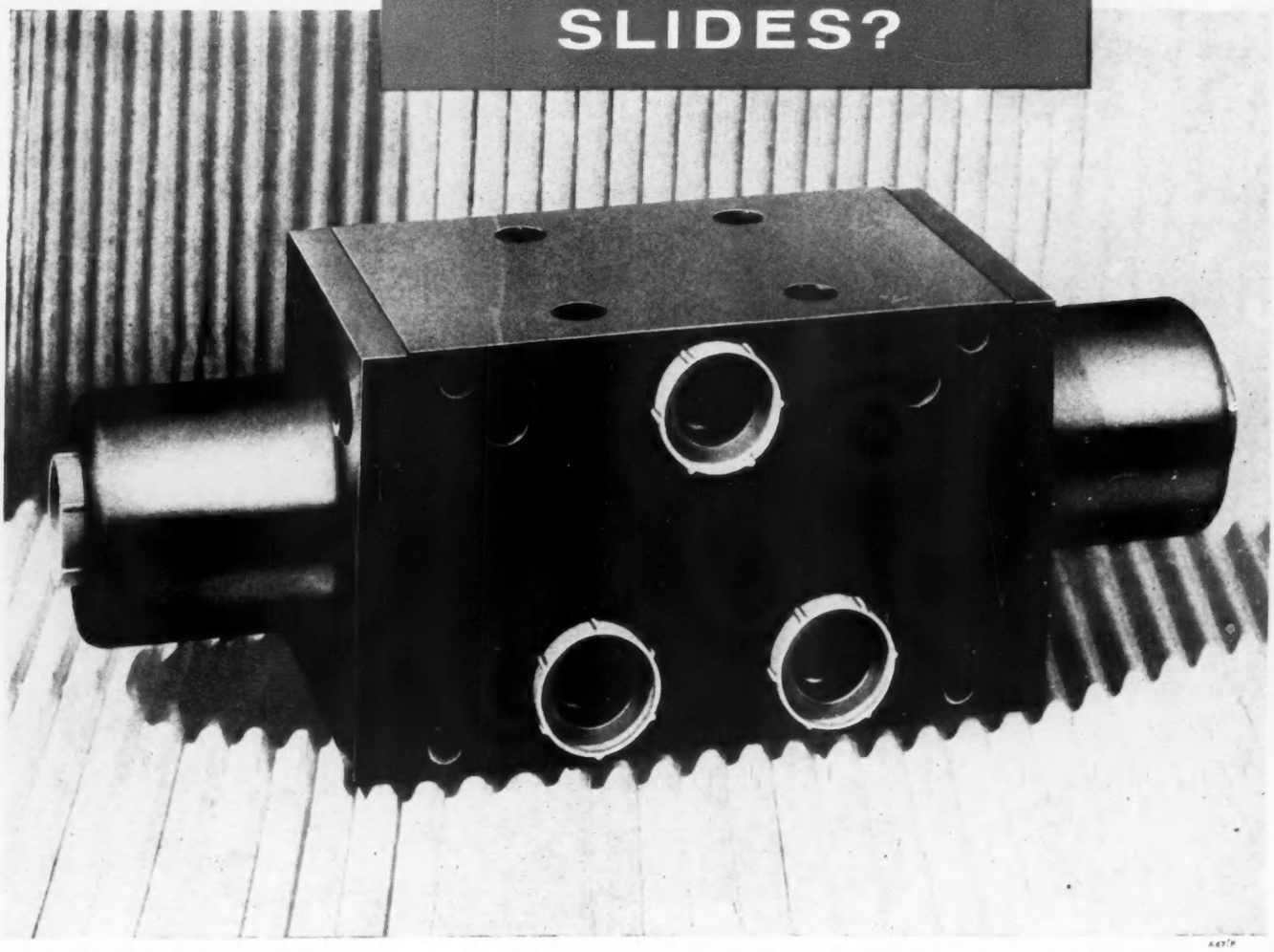

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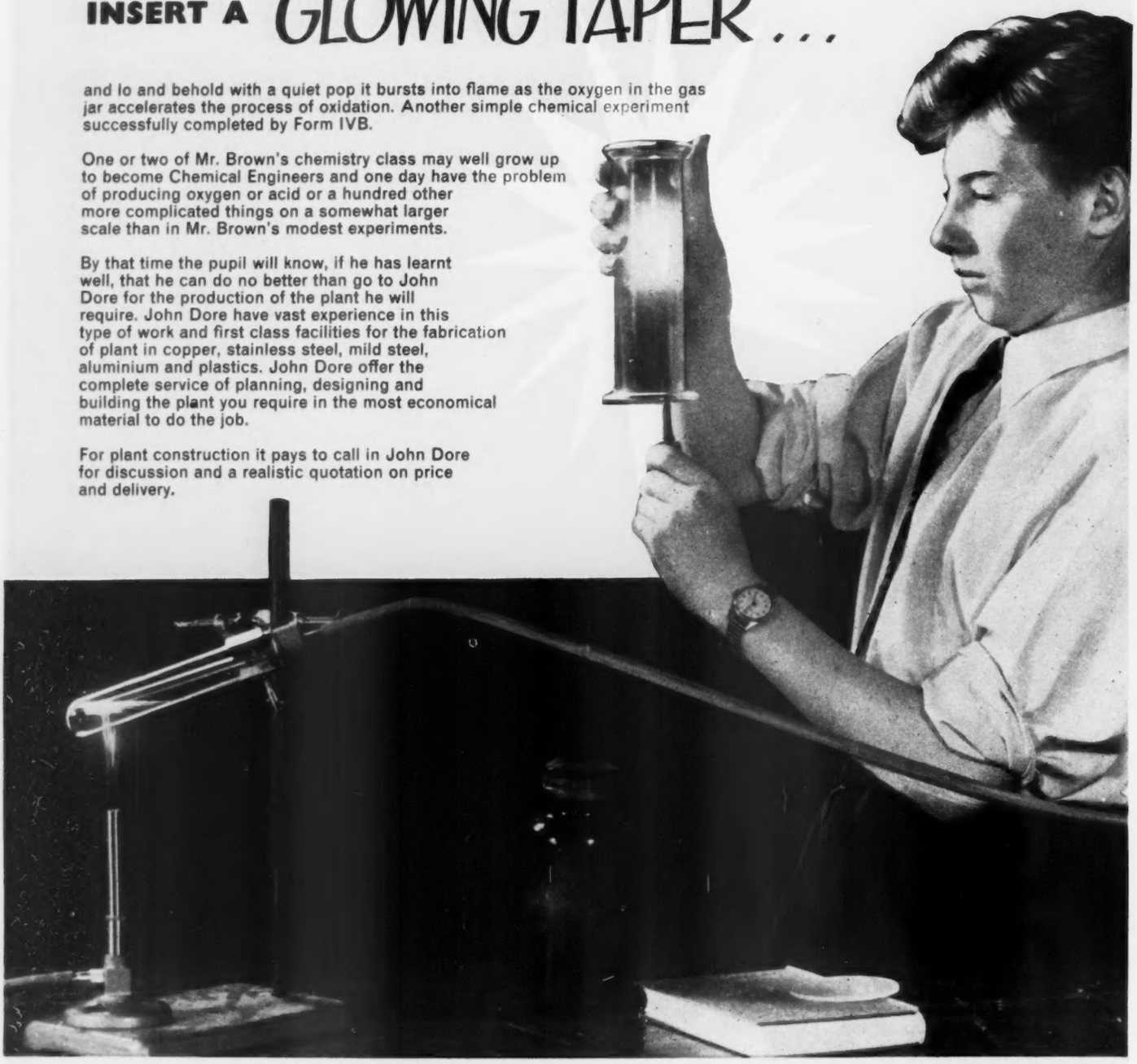

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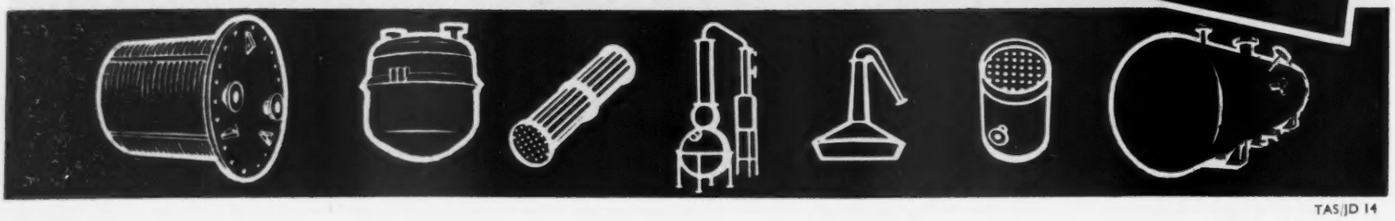

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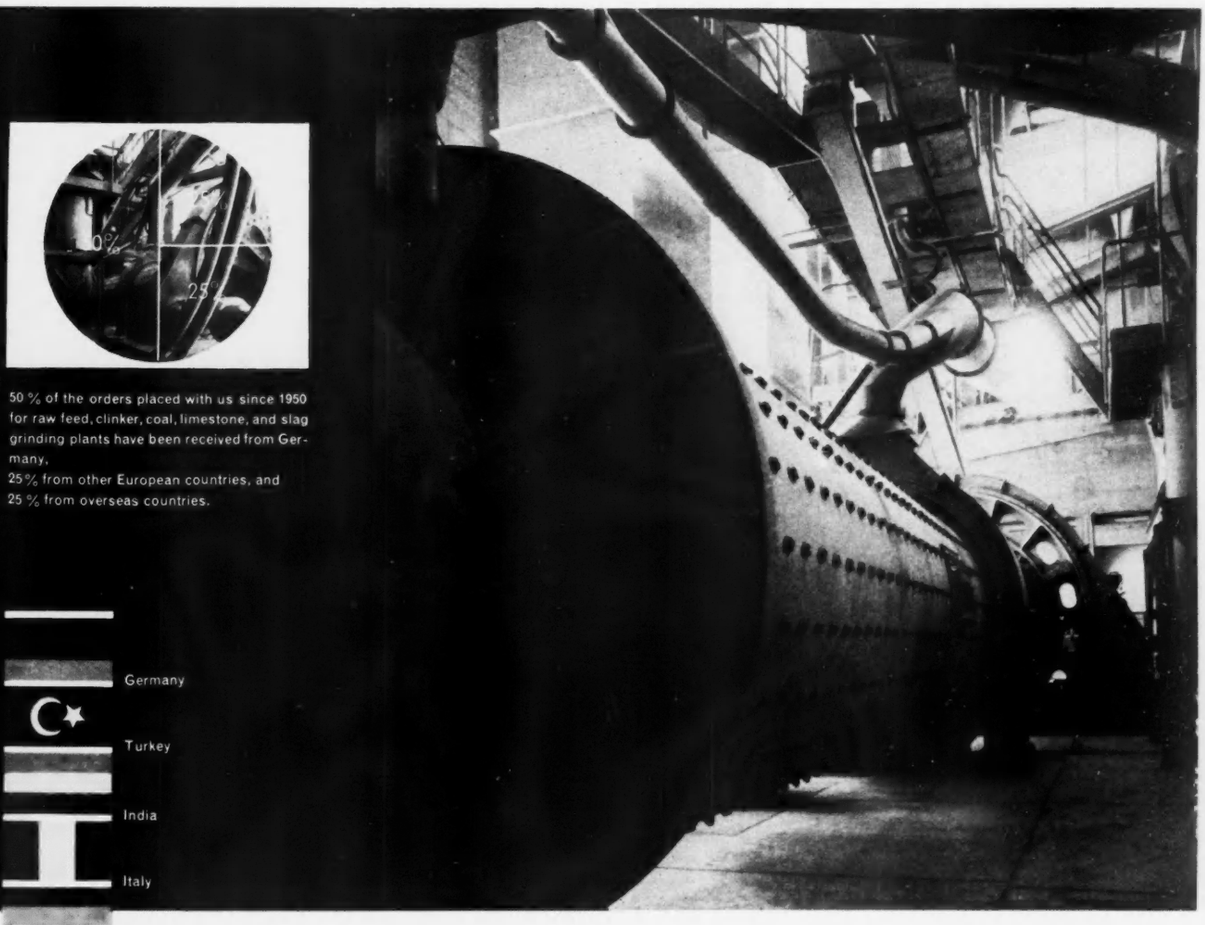

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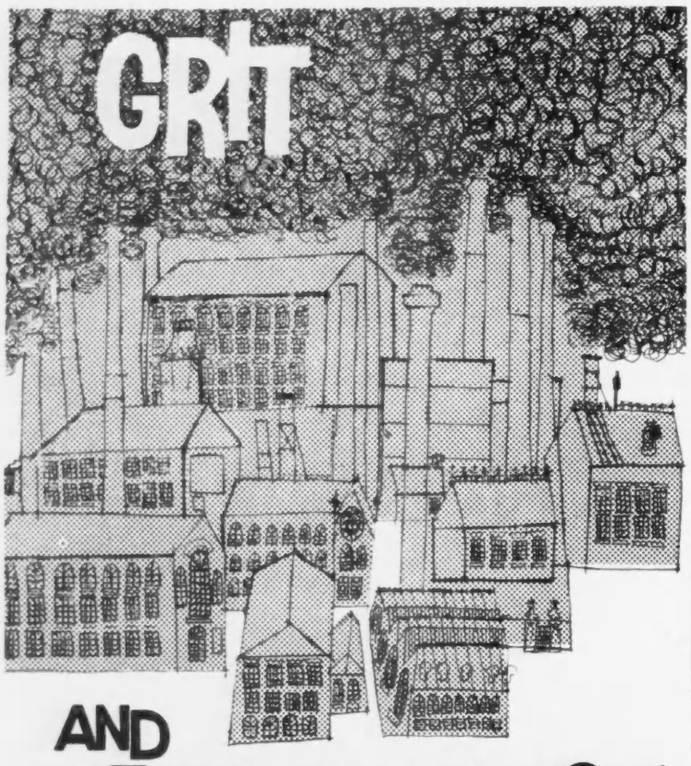

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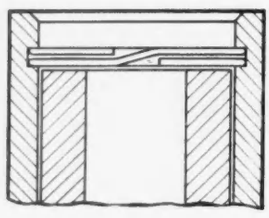

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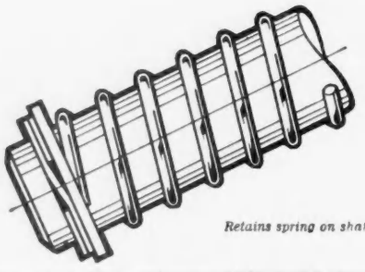

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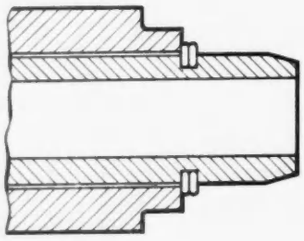

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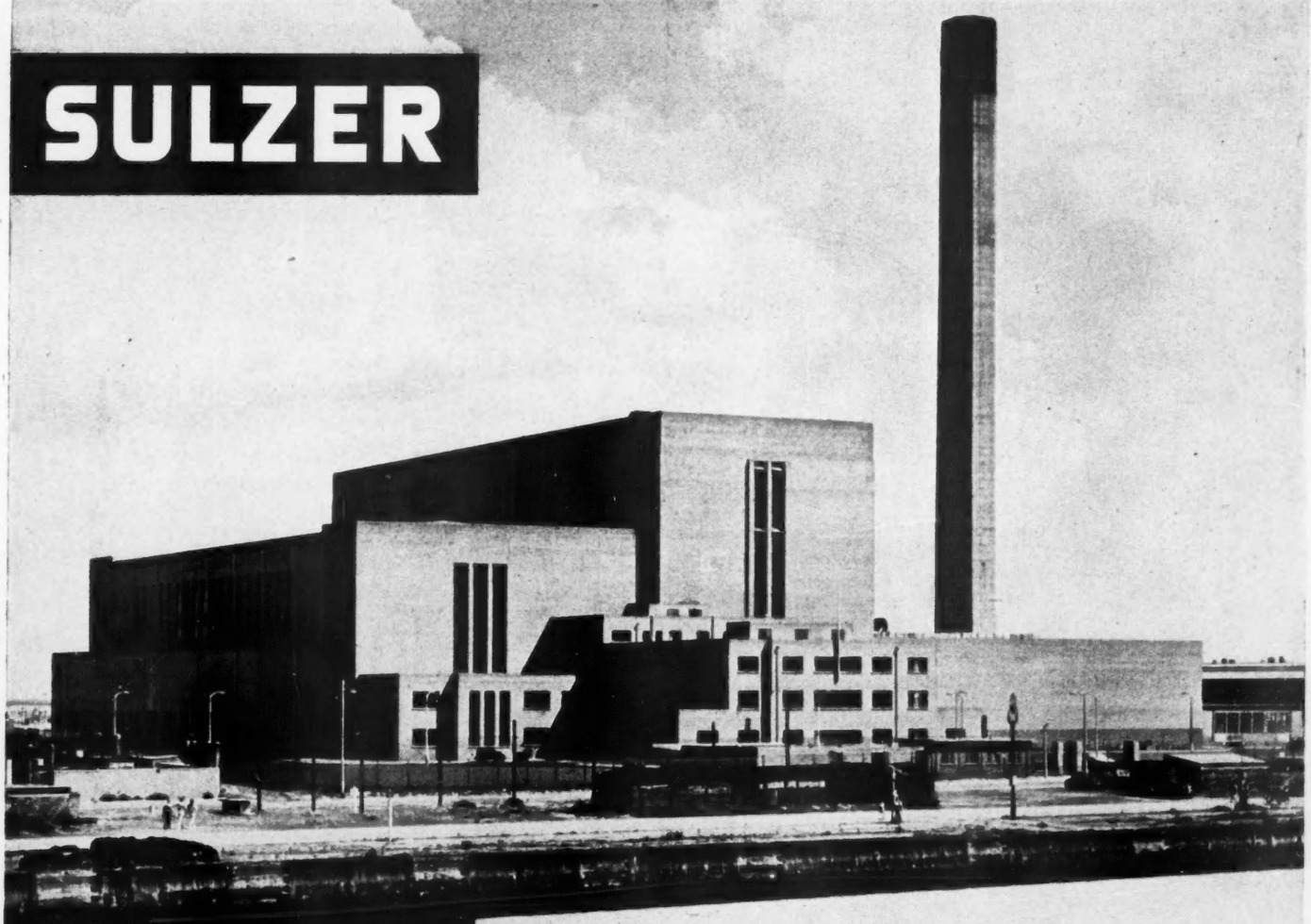

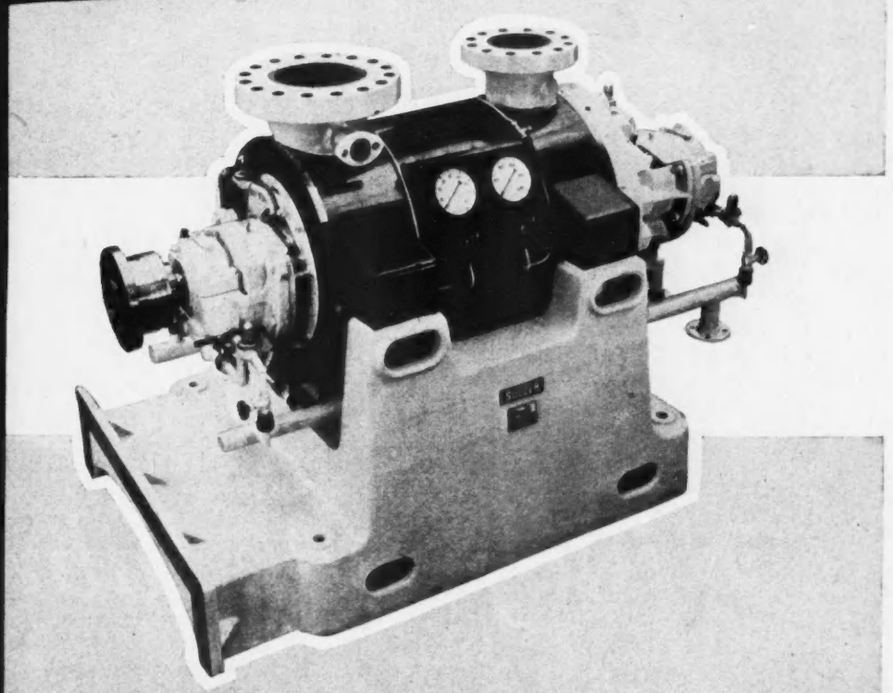

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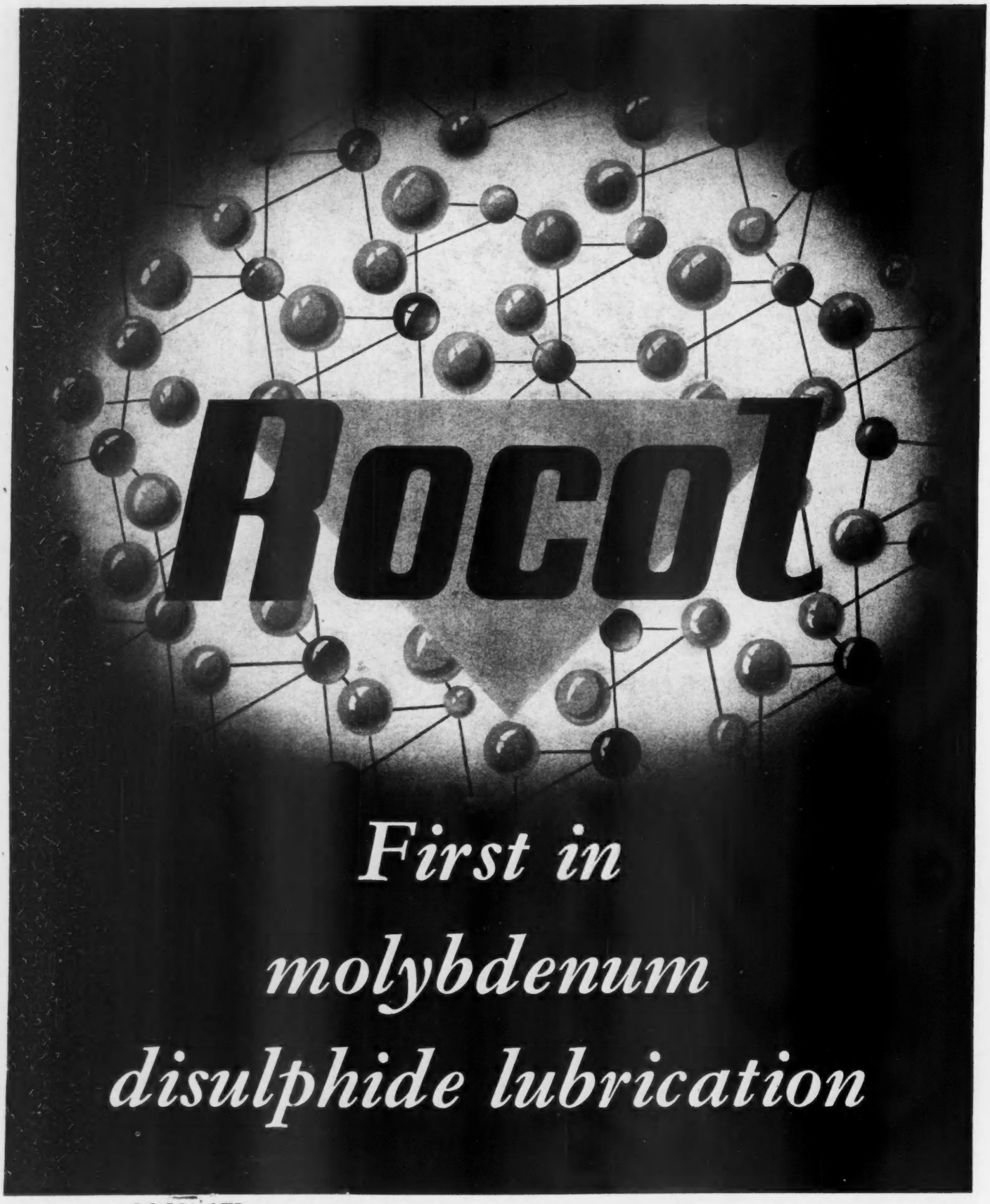

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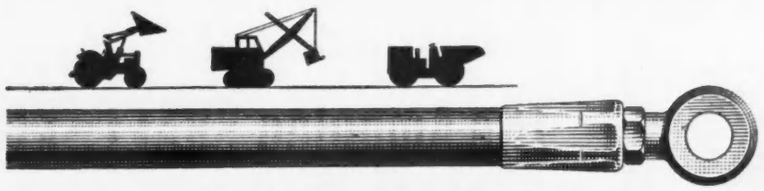

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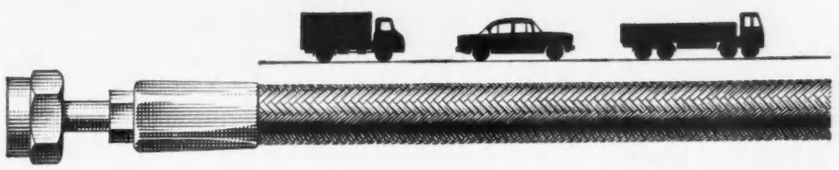

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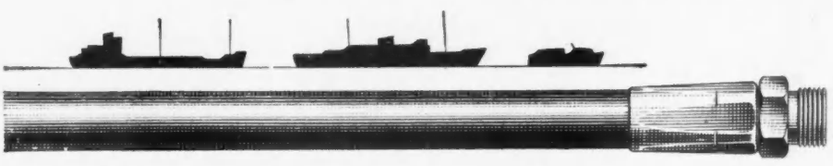

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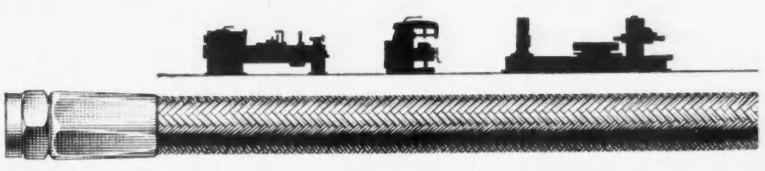

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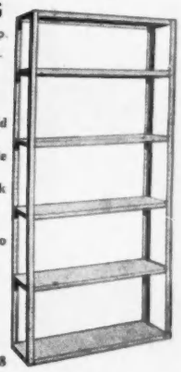

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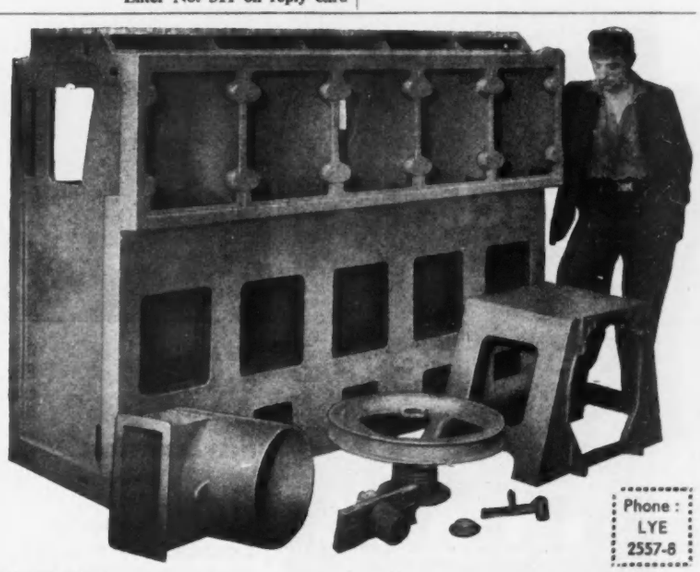

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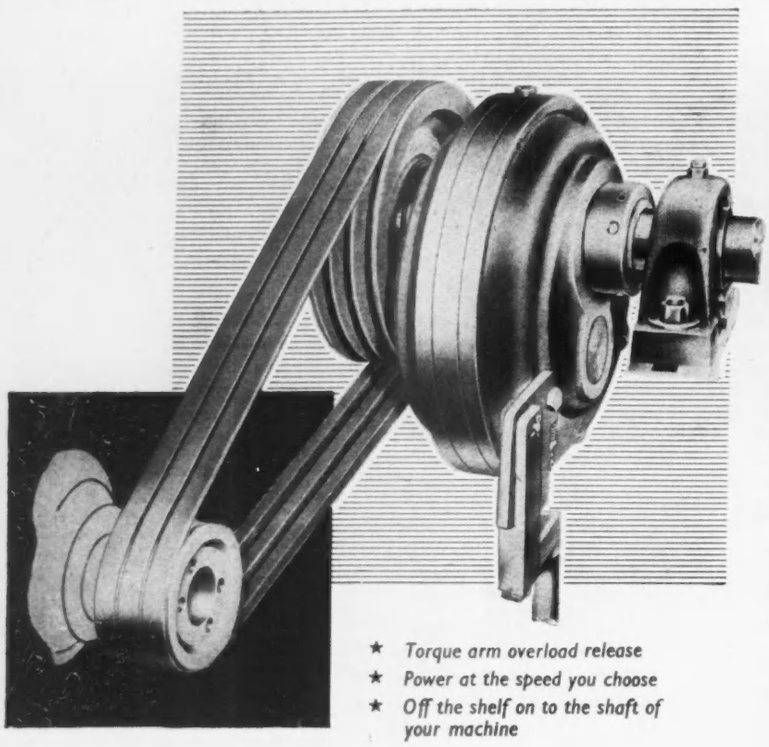

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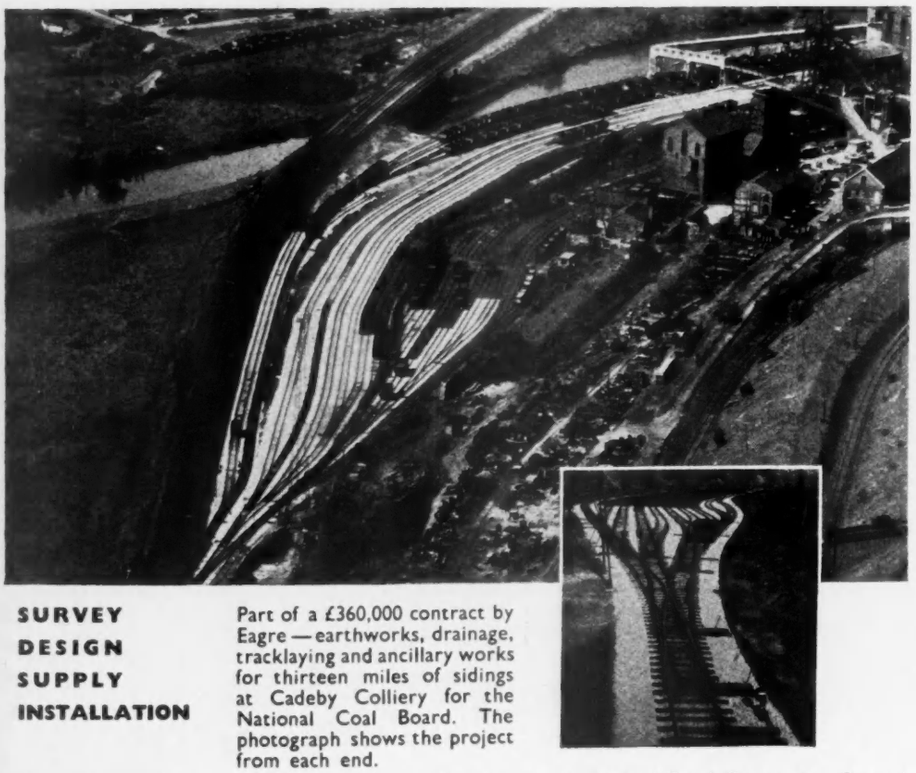

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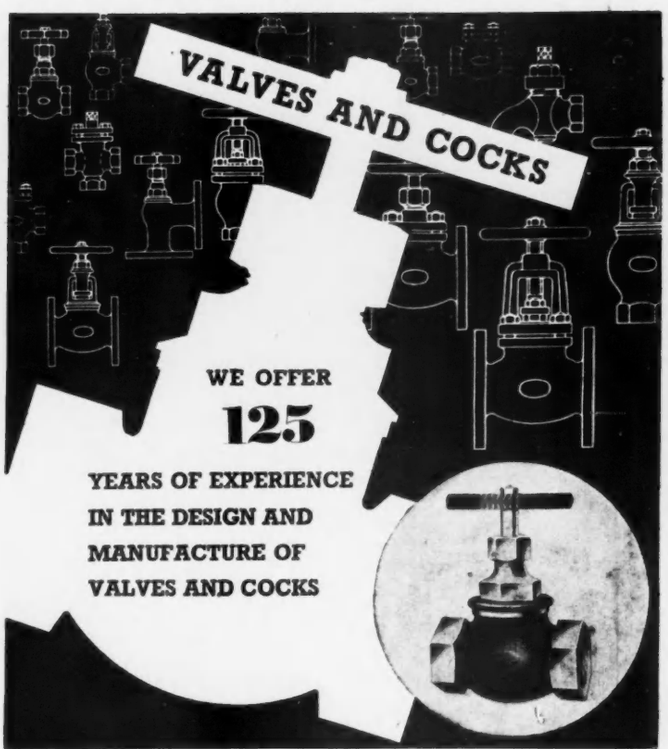

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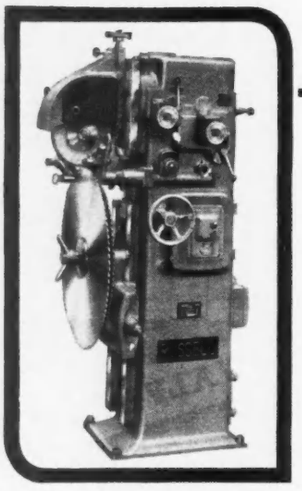

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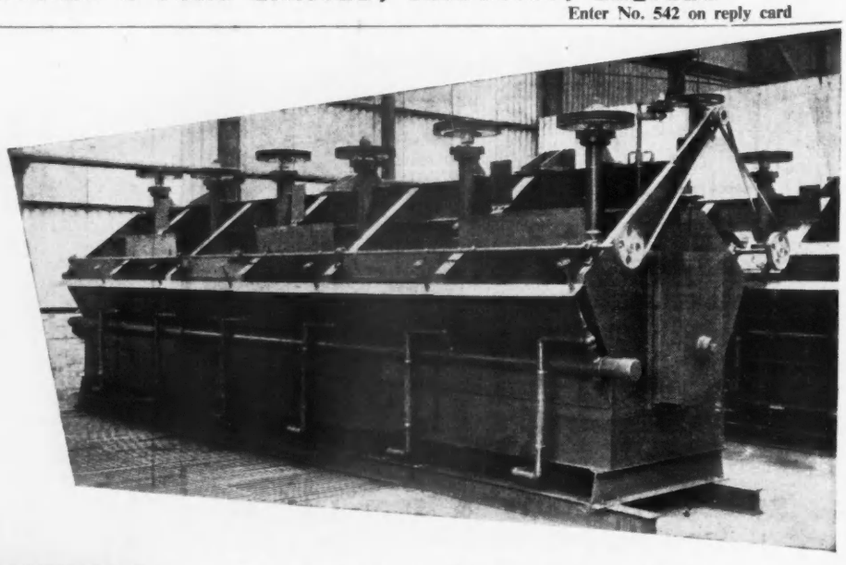

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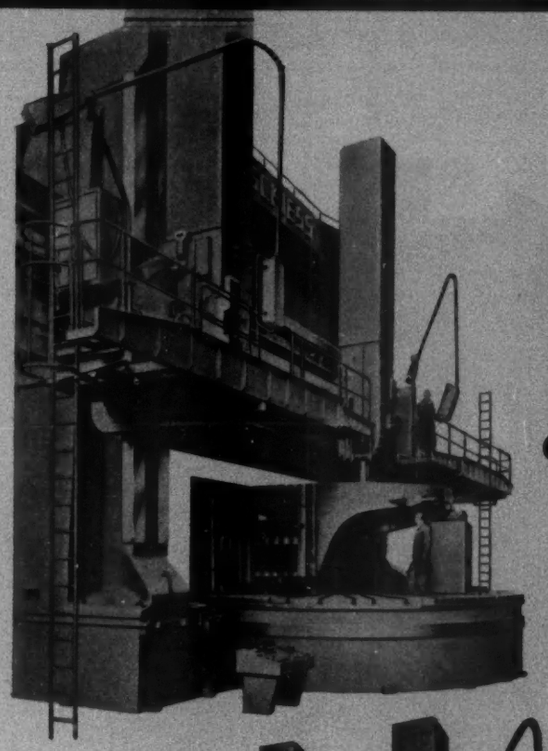

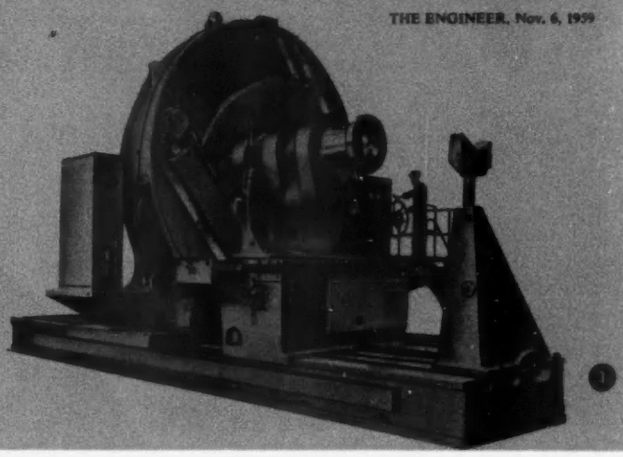

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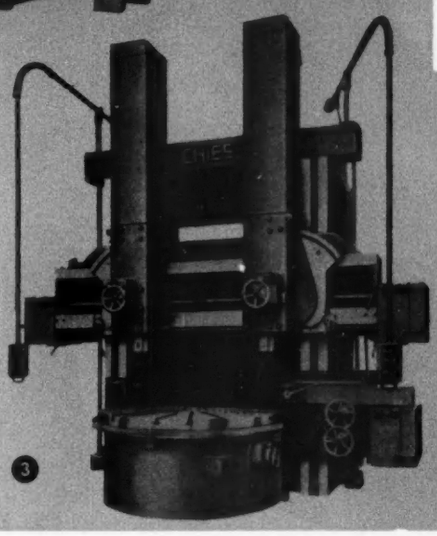
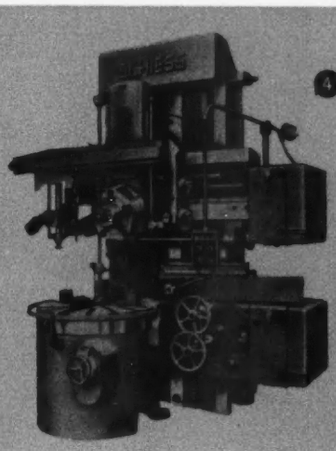
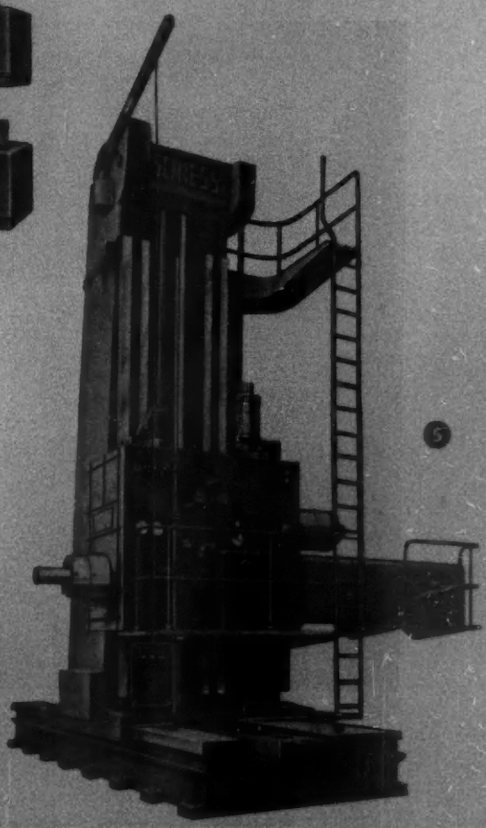
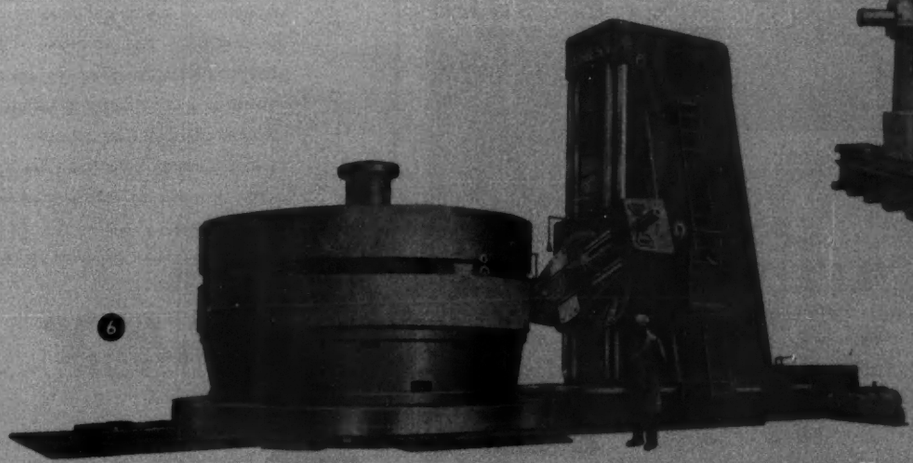






1. Crankpin Turning Machine KZA 285, with 112in. i.d. of ring.
2. Giant Vertical Boring Mill 26 GK 800/1000, with dual table. Maximum turning diameter 394in.
3. Double Column Vertical Boring Mill KZ 200. Maximum turning diameter 79in.
4. Single Column Vertical Turret Lathe KE 100, with copying device. Maximum turning diameter 39in.
5. Horizontal Milling and Boring Machine FB32/19, with 12⅝in. milling spindle and 7½in. boring spindle.
6. Precision Gear Hobbing Machine RF 40/60 S, shown with finish machined 157in. dia. marine turbine gear for transmitting 16,000 H.P.



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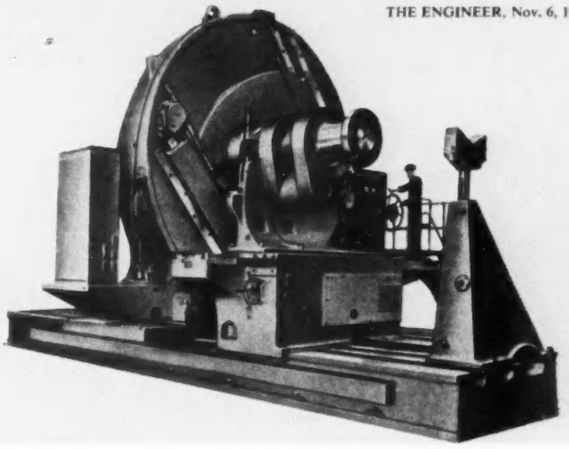

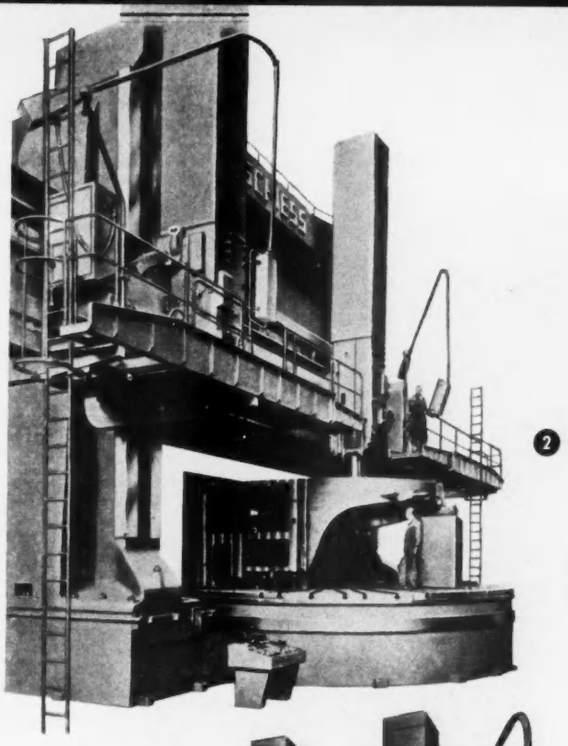

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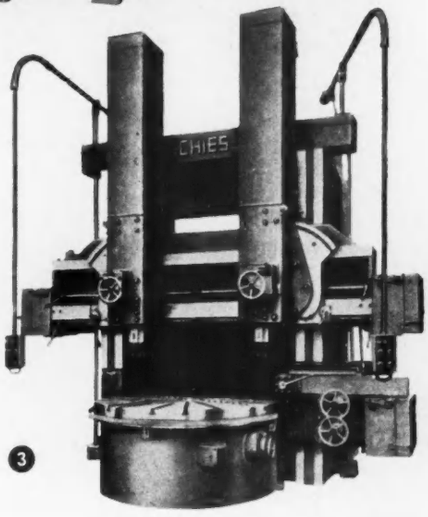

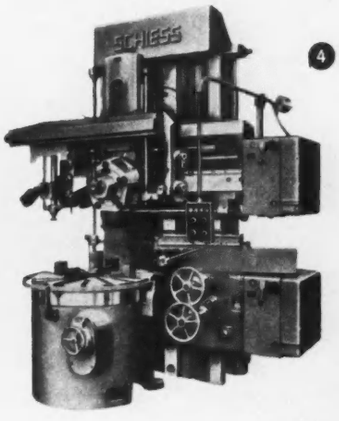

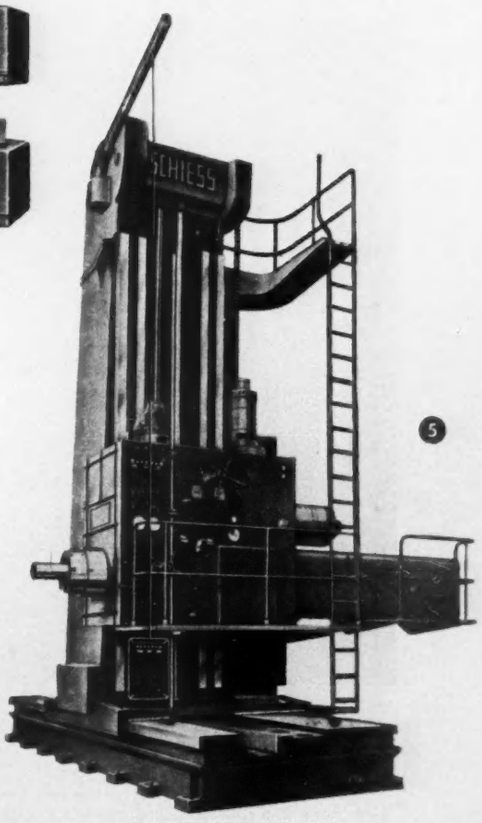

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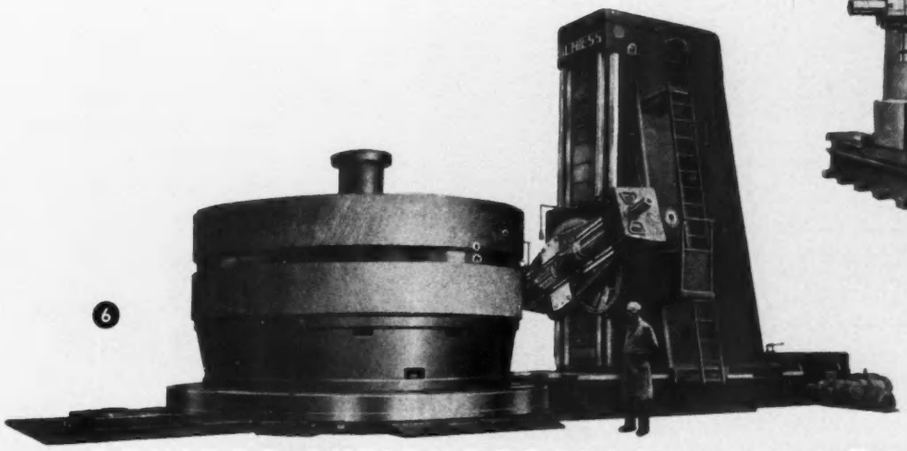

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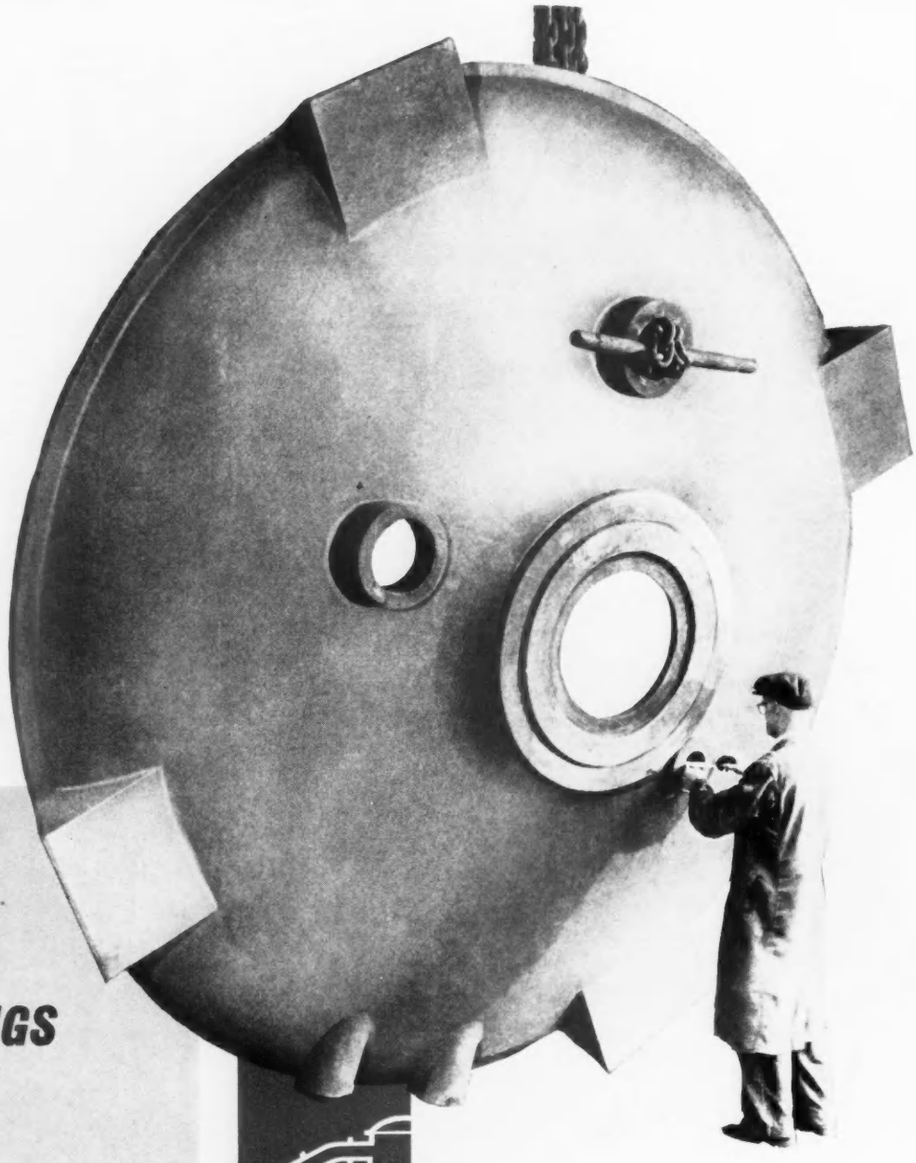

BUTTERLEY CASTINGS for sugar boiling plant in British Guiana

Large castings are required for the range of " Centre-Flow " Vacuum Pans for sugar boiling which are made by George Fletcher & Co. Ltd. of Derby. The photograph above shows the one-piece bottom of a 12ft. diameter vacuum pan made in the Butterley foundry. The casting made in Type GE1 Meehanite is part of a pan for British Guiana and weighs 4 tons 14 cwt.

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It is the ultimate cost
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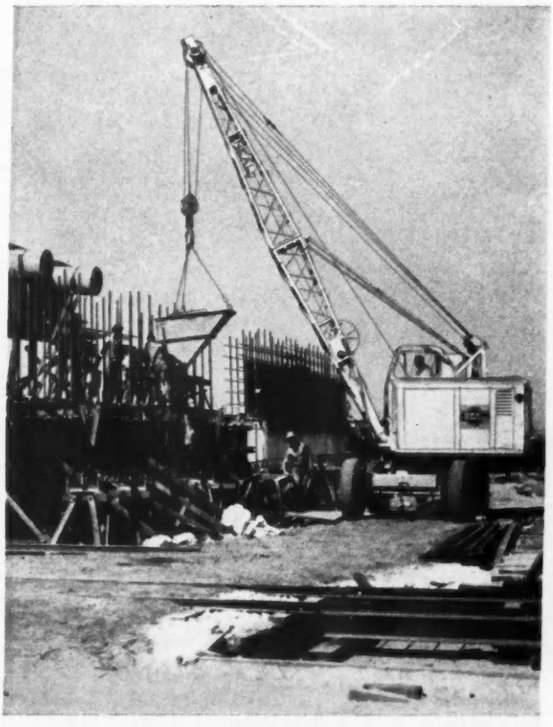

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RTB CASTINGS SUPPORT THE DAN-Y-GRAIG RAILWAY BRIDGE

TOP PICTURE:
One of the eight slipper block supports

LOWER PICTURE:
The master support

Photographs reproduced by permission of Mr. M. G. R. Smith, Chief Civil Engineer, British Railways Western Region.

This steel bridge, designed and being erected by British Railways Western Region on the by-pass at Swansea, eliminates two dangerous bottlenecks.

The new steel superstructure, fabricated by Fairfield Shipbuilding & Engineering Co. Ltd. of Chepstow, is supported at nine points: at one there is a pivoted master support controlling the position of the whole bridge; the other eight supports can pivot and slide to allow for expansion.

These castings, of special S.G. iron, came from the Richard Thomas & Baldwins foundry at Machynys, completely machined and ready for erection.

Our foundries and engineering works in South Wales produce all types of ferrous castings up to 10 tons (iron castings up to 30 tons in certain cases) and non-ferrous castings up to 1 ton. We have well-equipped shops for steel fabrication, constructional and general engineering work.

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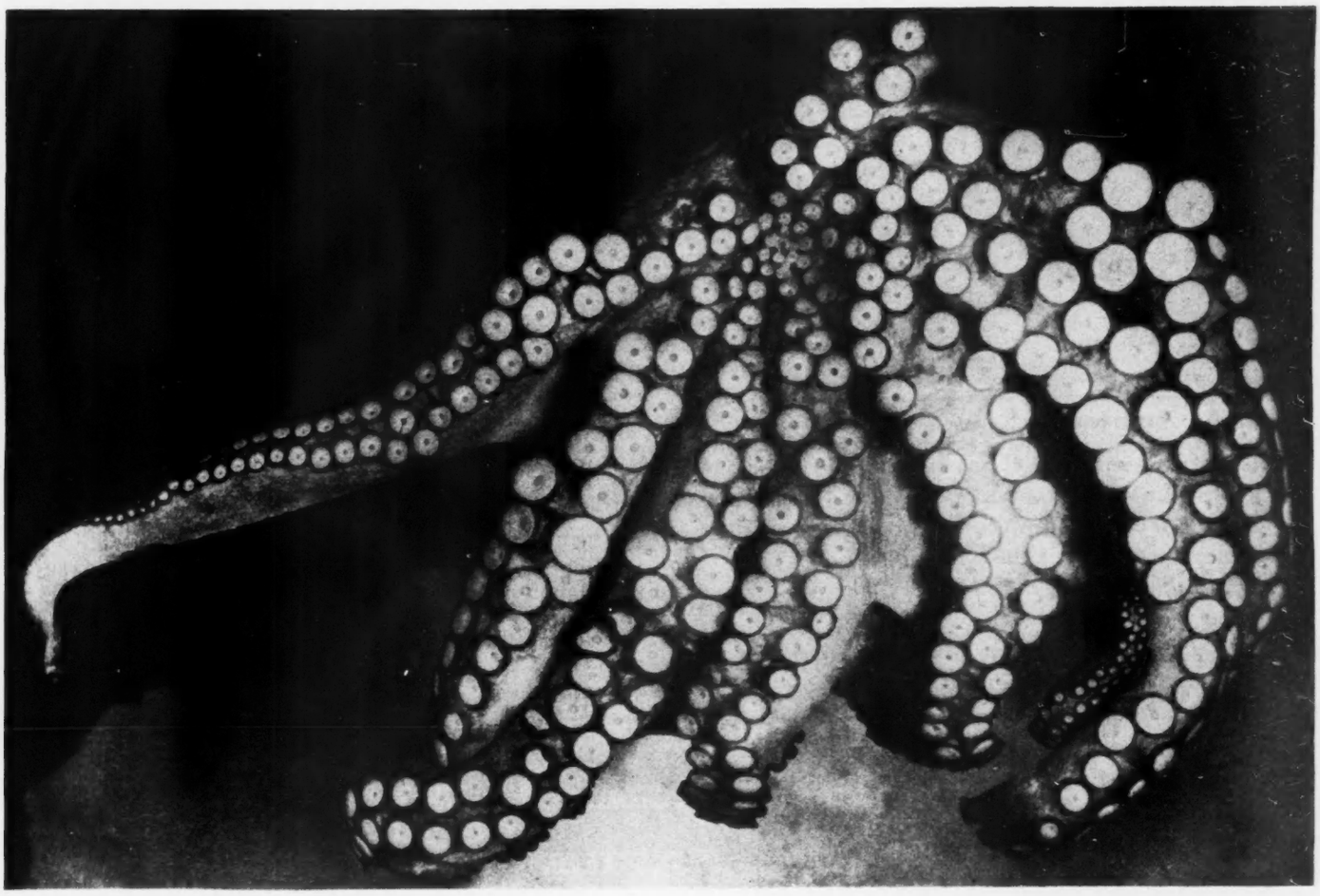

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Octopus-like, this KING installation at the Banbury Works of the Northern Aluminium Co. Ltd., handles aluminium slabs 90 ft. long, 7 ft. wide, ½ inch thick; octopus-like—by tentacles and suction. 44 suction pads are suspended from the lifting beam manifold, each having an automatic cut-off device to prevent loss of vacuum when shorter slabs are required to be lifted. All this is remotely controlled by one operator—yet another example of the superb ingenuity and efficiency of the KING approach.

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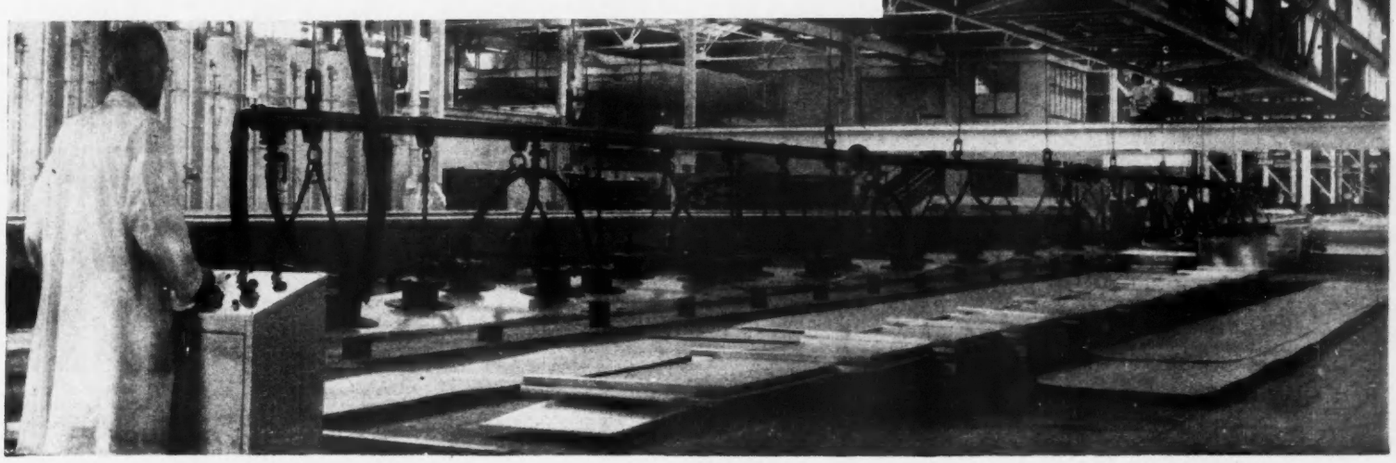

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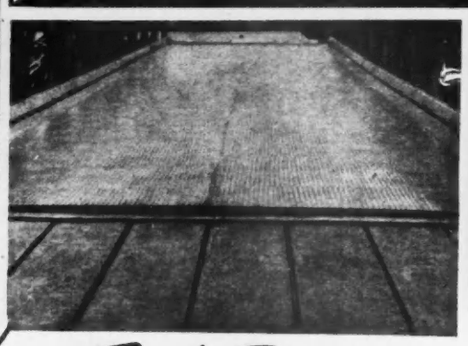

...on a Trunk Road in Scotland

COURTESY: SCOTTISH HOME DEPARTMENT (ROADS DIVISION)

With the increase in weight of modern traffic, many of the older type of bridges may require to be strengthened, particularly in order to carry abnormal indivisible loads. In this particular project a Bailey Bridge is erected on the existing stone piers and decked with Storey Steel Decking which is asphalt carpeted.

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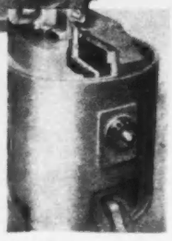

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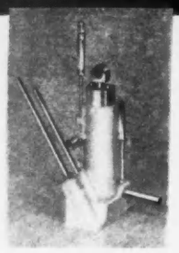

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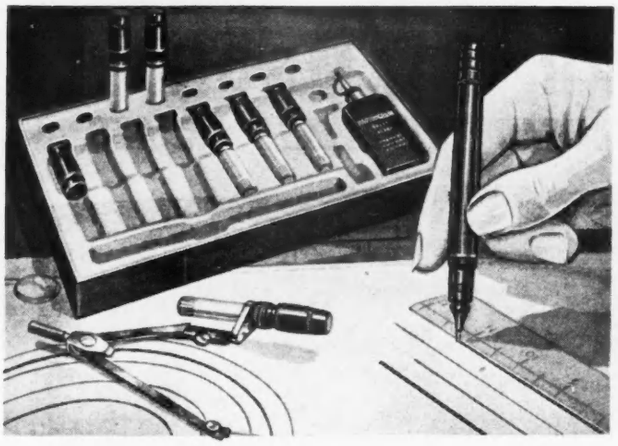

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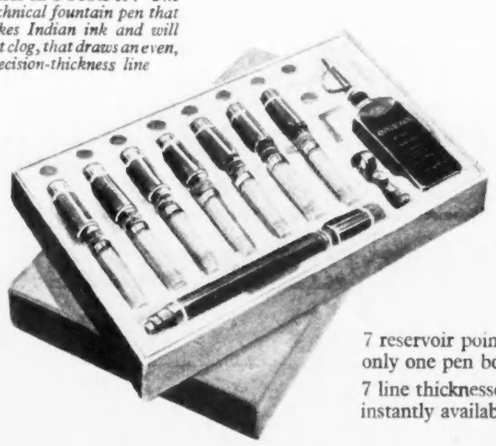

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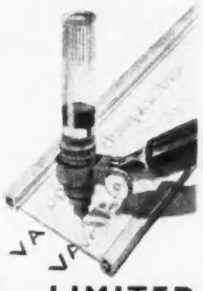

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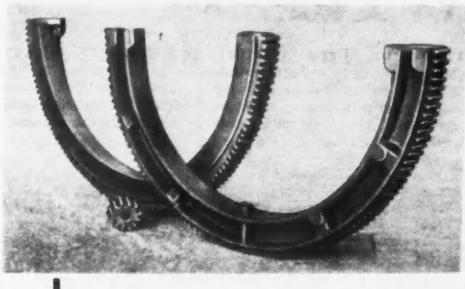

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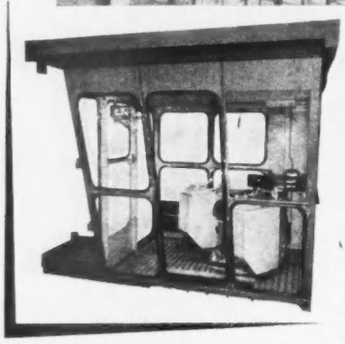

★ *a view of the cab showing the seat control unit.*

The Adamson 50/10 ton crane is the third of a series of new design supplied to Richard Thomas & Baldwins Limited, Ebbw Vale Section. Features of the crane include monolithic construction of the crab and the elimination of castings by mild steel fabrication of the hoist barrel and bottom block. The cab is of particular interest as it incorporates the most modern type of seat unit ensuring maximum vision and ease of control. Joseph Adamson electric overhead travelling cranes can be supplied to all specifications including cranes suited to the most exacting 24 hours-a-day process work.

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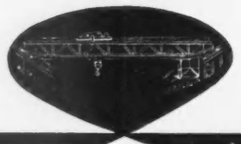

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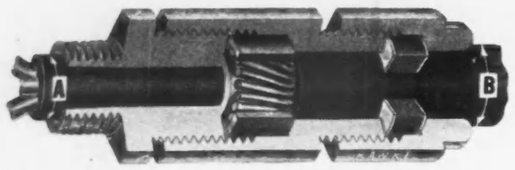
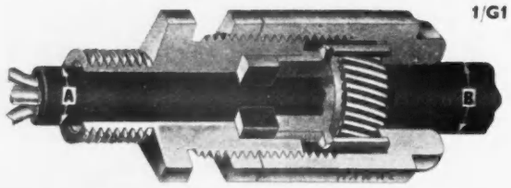


9/G3

1/G1



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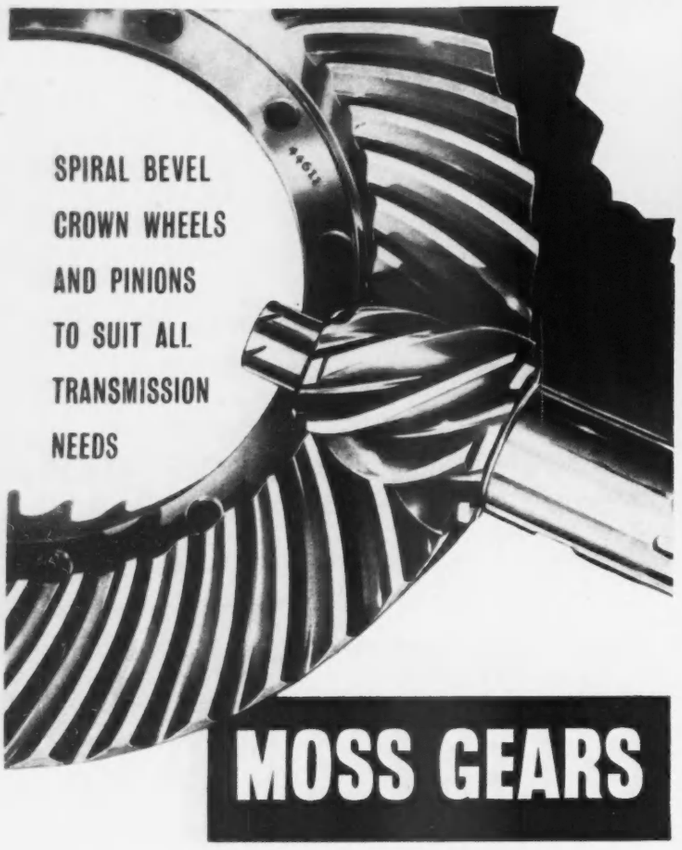

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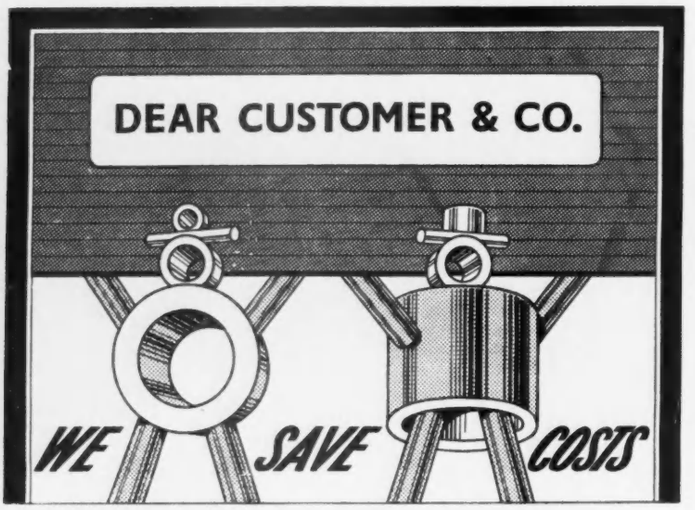

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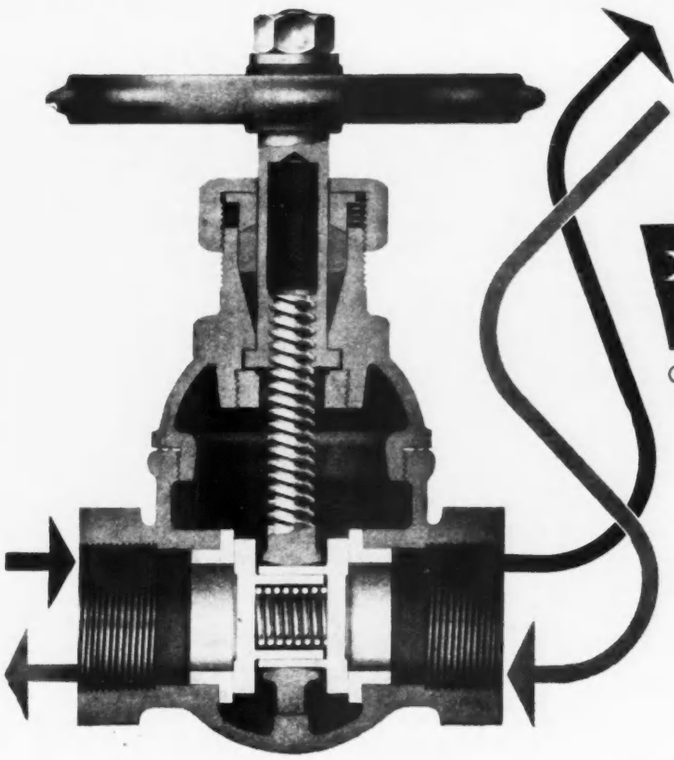

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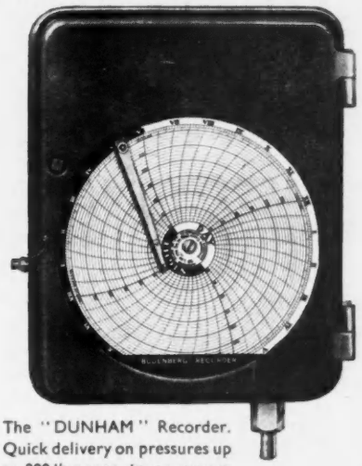

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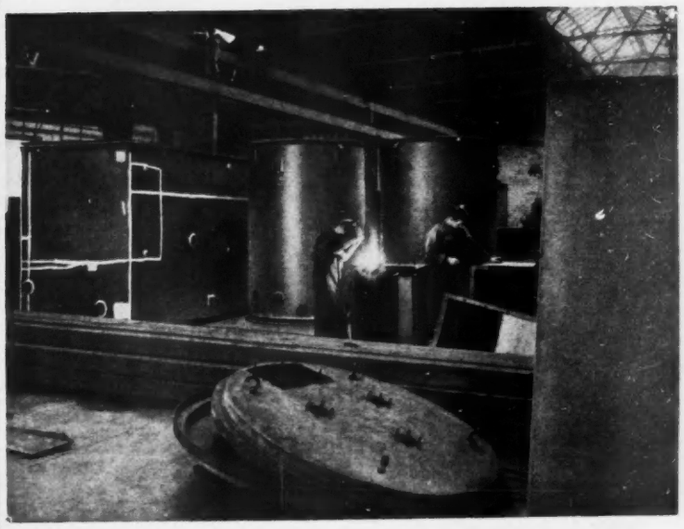

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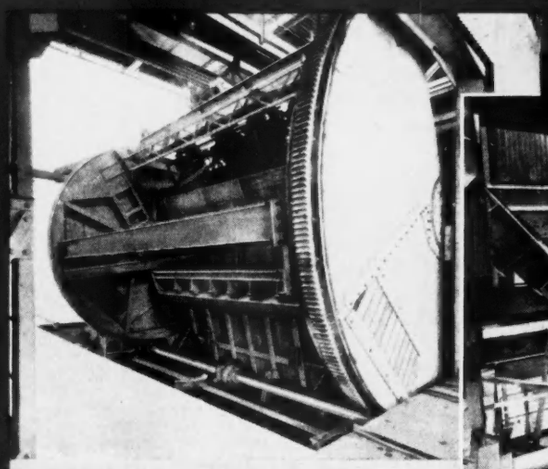
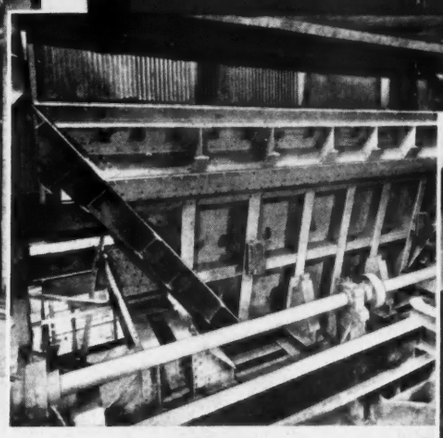
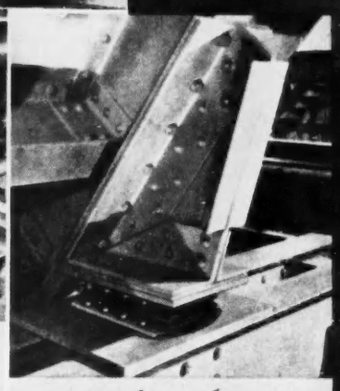


Ore is tipped out of the truck here . . .



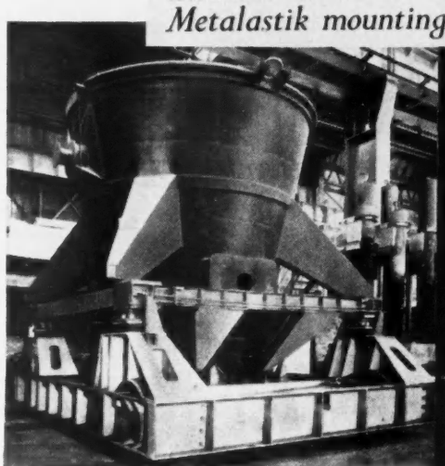
falls into this hopper . . .



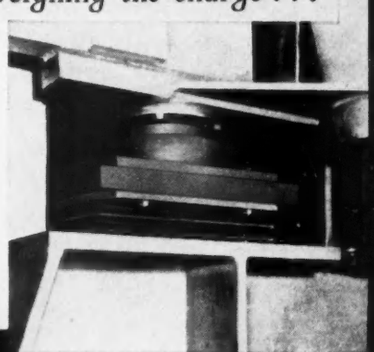
mounted on 6 Metalastik mountings.

Softening the shock loads

At the Stanton Ironworks, ore is discharged from railway wagons by means of a tippler and crashes into a hopper. Normally 25-35 tons may be discharged in 30 seconds, sometimes in a steady stream but occasionally lumps of iron ore, exceeding 3½ tons fall 10-ft., resulting in impact loads which are considerable and could be damaging. Furthermore the vibration and shock impulses—unless checked—would be transmitted to adjacent buildings and plant. Accordingly the suppliers of the plant, Mitchell Engineering Ltd. called in Metalastik to reduce the harmful effects by providing mountings which normally support 11 tons each, deflecting 0.1". Under the extreme conditions already mentioned the deflection is 0.3", making a very considerable reduction in the shock effect. A similar problem arose at Samuel Fox's works in Sheffield where a magnet crane discharges large masses of scrap metal into a 60-ton scale transfer car from a considerable height. The loadcells employed had to be safeguarded from excessive shock loads in order to maintain their high accuracy indefinitely. Davy and United Instruments Limited, who engineered the loadcell weighing equipment into the installation, met the problem by incorporating Metalastik mountings as illustrated in the accompanying pictures. Whether for a small instrument, a diesel engine or a great piece of industrial plant, Metalastik mountings can always improve the conditions.



On this transfer car for weighing the charge . . .



. . . the 'loadcell' is protected by Metalastik mountings.

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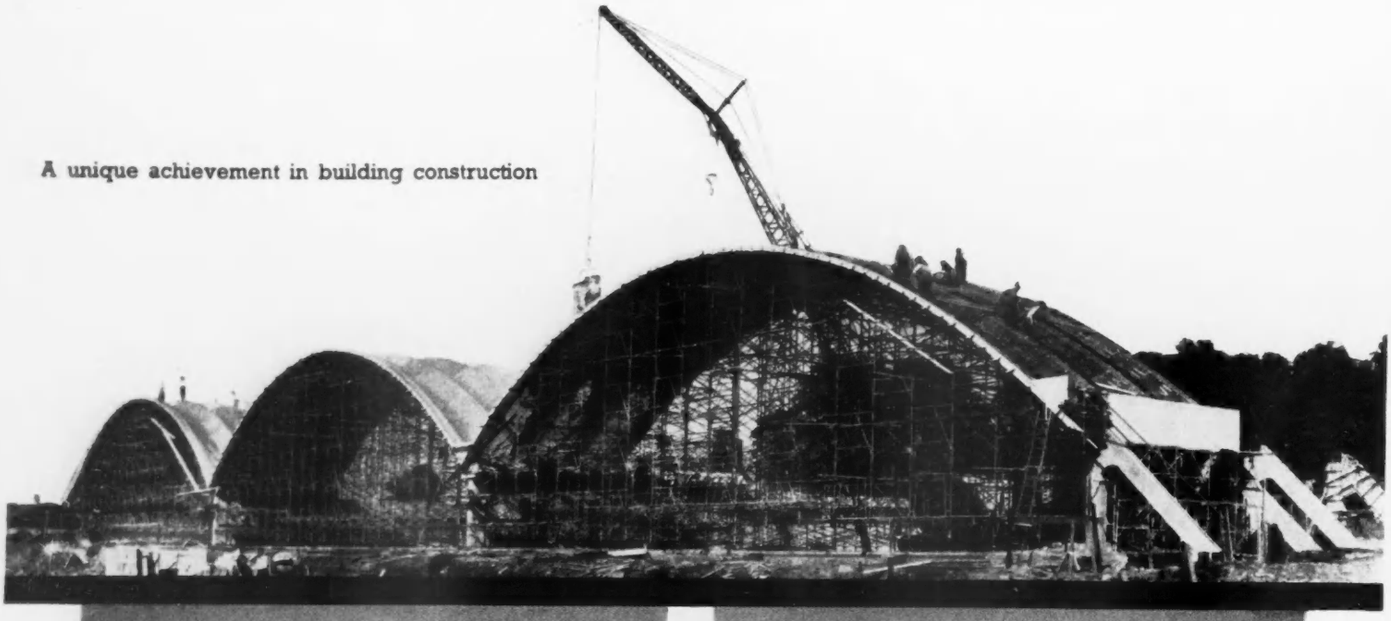

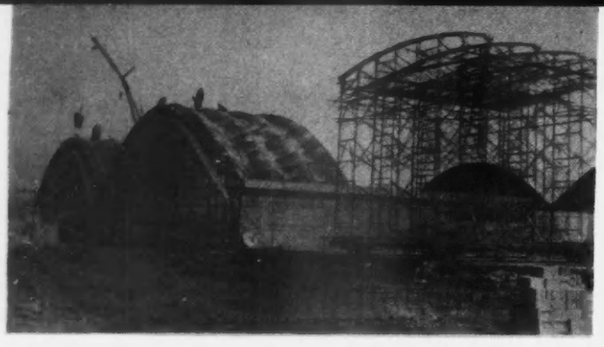

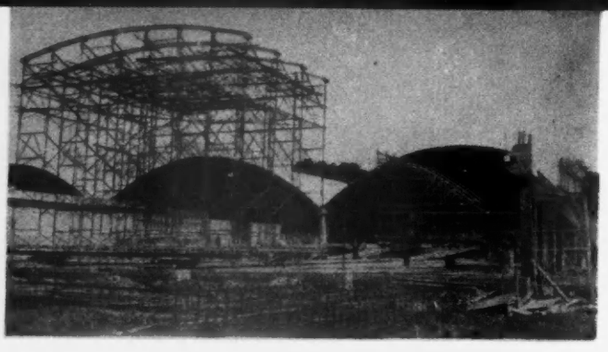

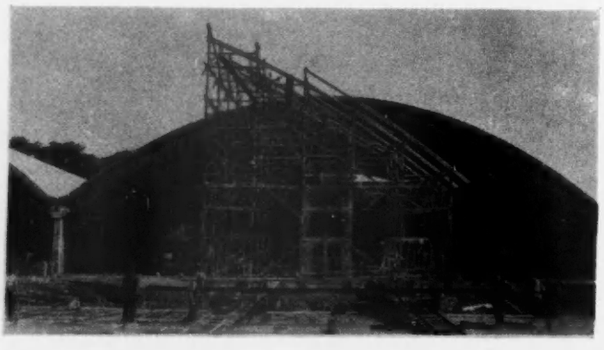

Leggat's achieve a 7 day 'pour and strike' cycle for each 3 span 25 foot section of these Ctesiphon Warehouse roofs at Paisley.

These pictures show the construction of two warehouses each with 3 roof spans of 100ft. for Messrs. Chivas Brothers Ltd., Scotch Whisky Distillers and Exporters, at Paisley by Messrs. Hugh Leggat Ltd., of Glasgow. The roofs are of Ctesiphon Construction and consist of 2½" thick reinforced concrete corrugated arch shells each spanning the full 100ft. Each corrugation has a pitch of 8ft. 4ins. and an overall depth of 2ft. 2½ins. A pre-requisite in designing a scaffolding mobile of this character is the high degree of accuracy required; the whole arrangement working to a tolerance of ⅛".

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SEE US AT STAND No. 467, ROW D, GRAND HALL, OLYMPIA, BUILDING EXHIBITION, NOV. 18 to DEC. 2, 1959.

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CREDITS

ARCHITECT — S. Lothian Barclay, M.A., A.R.I.B.A., A.R.I.A.S., Glasgow.
CONSULTING ENGINEERS — J. H. de W. Waller, D.S.O., O.B.E., M.Sc., M.I.C.E. London, and A. C. Astor, B.Sc., A.C.G.I., B.I.C., London.
CONTRACTOR — Hugh Leggat Limited, Barrhead, Glasgow. Licensees for Ctesiphon Construction.
PATENTEES FOR ROOF — Ctesiphon Construction Limited, 167 Victoria Street, London, S.W.1.

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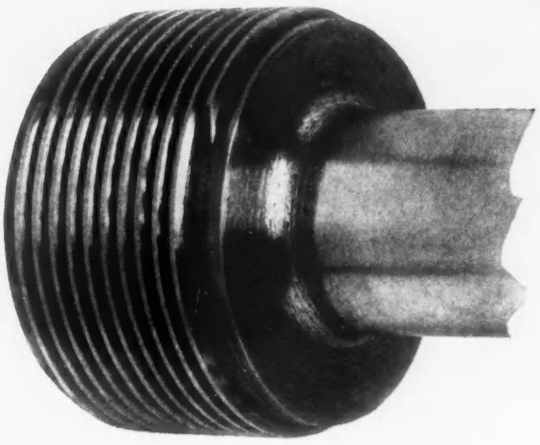

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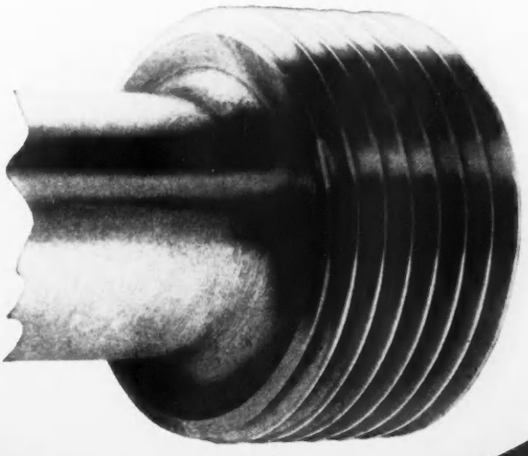

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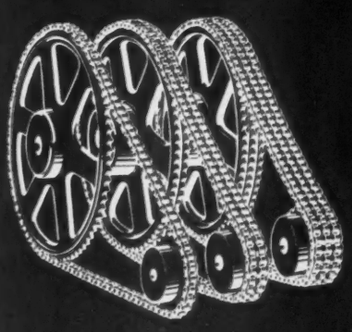

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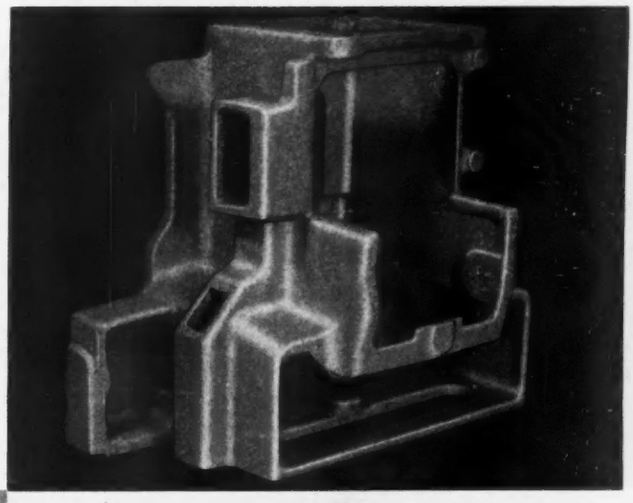

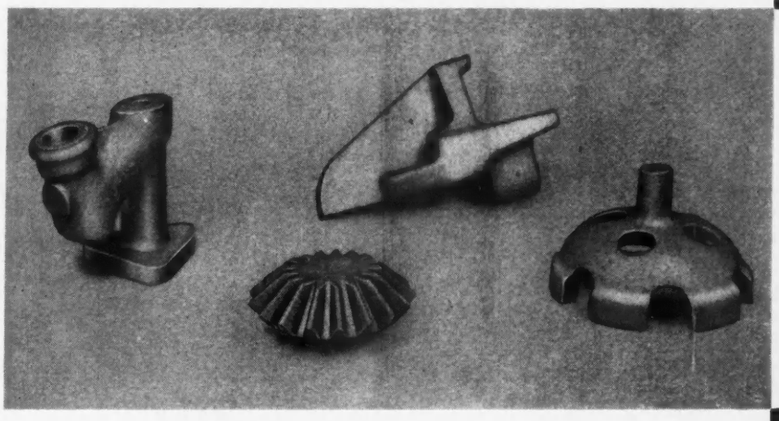

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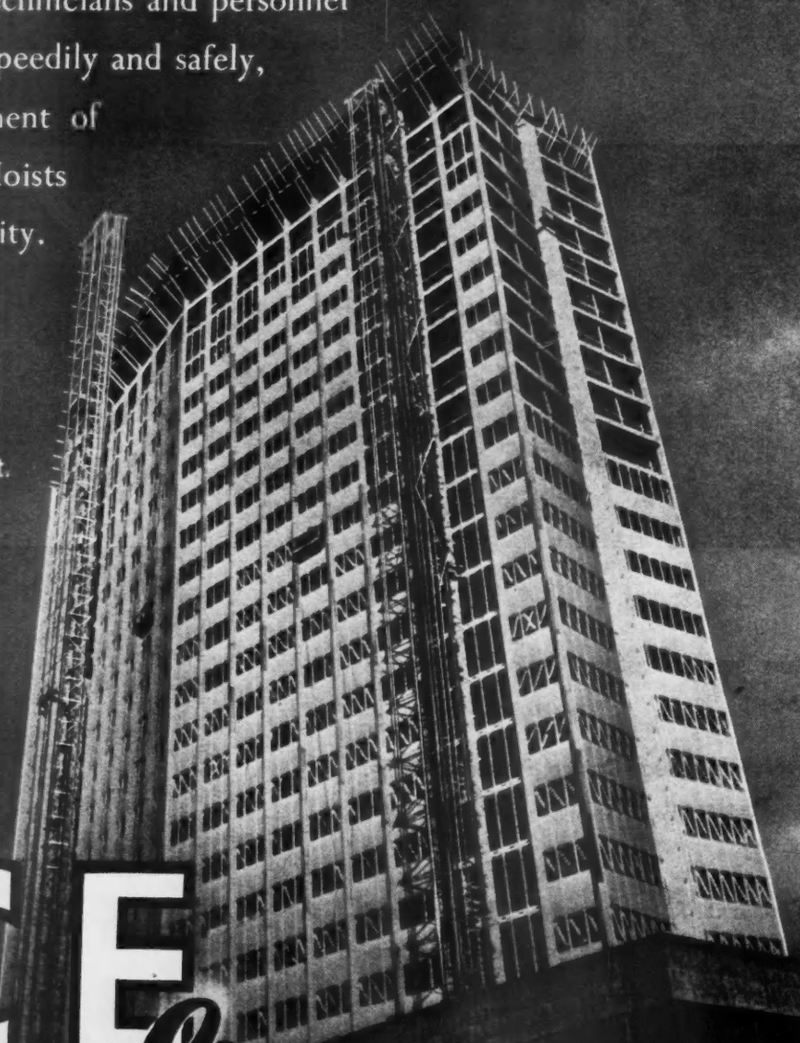

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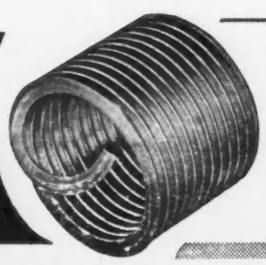

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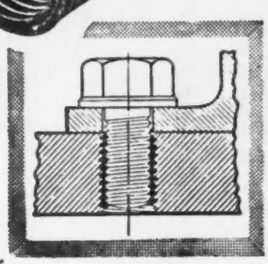

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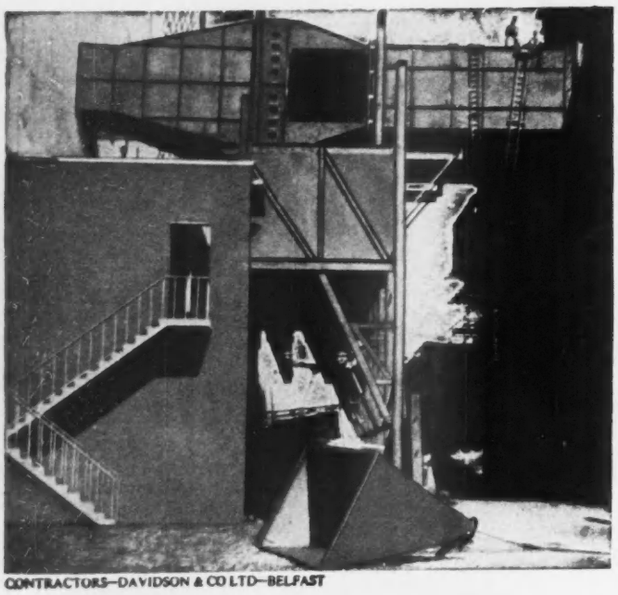

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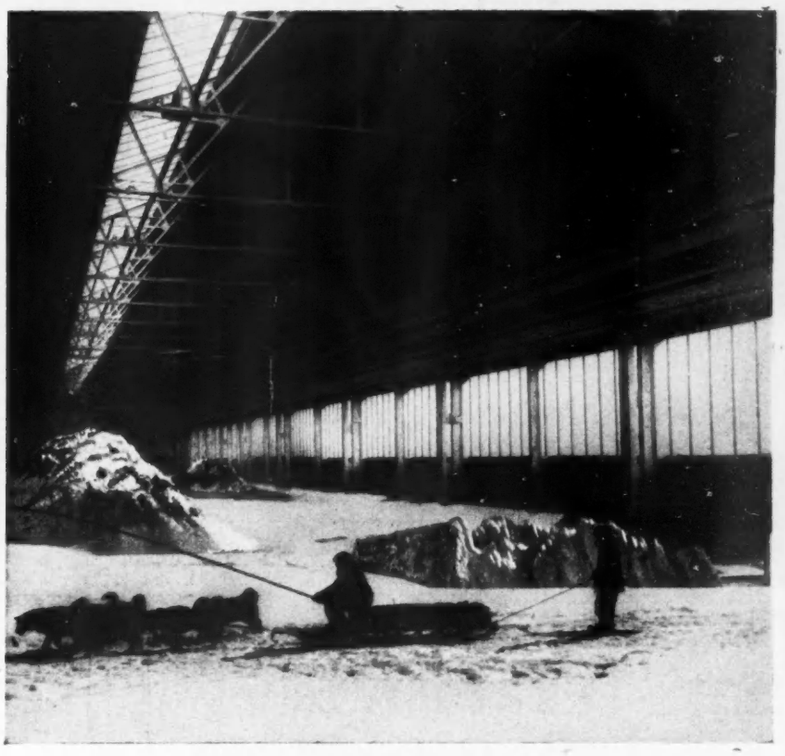

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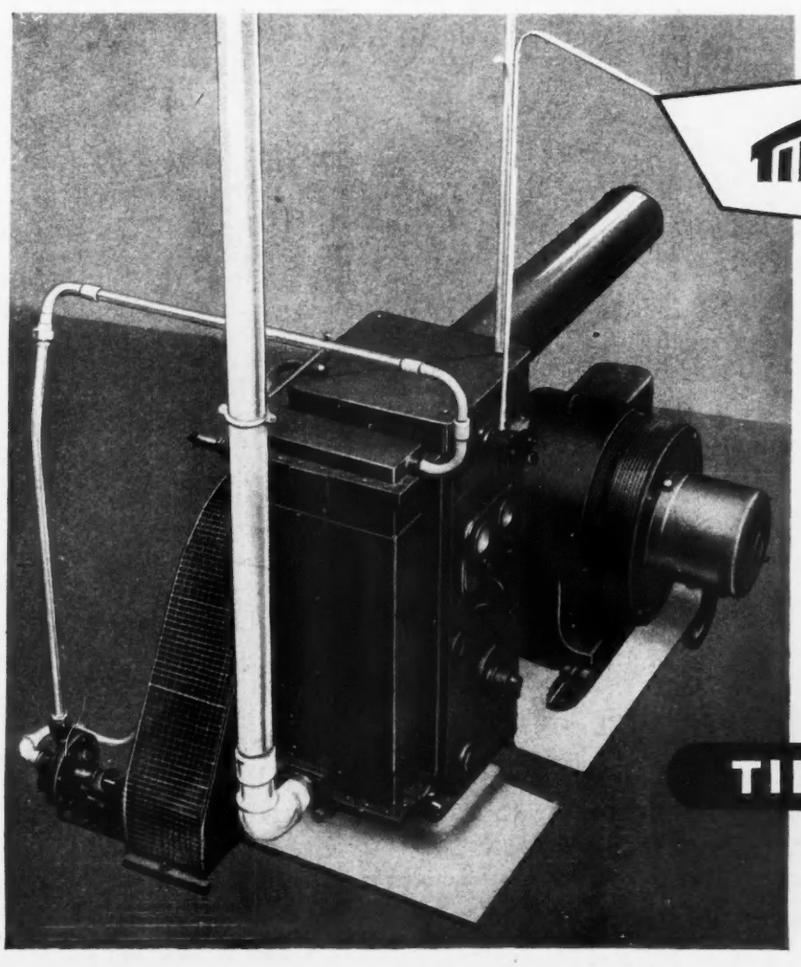

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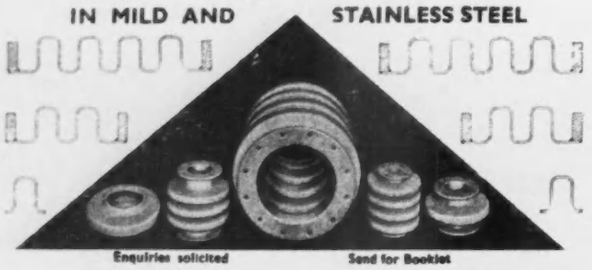

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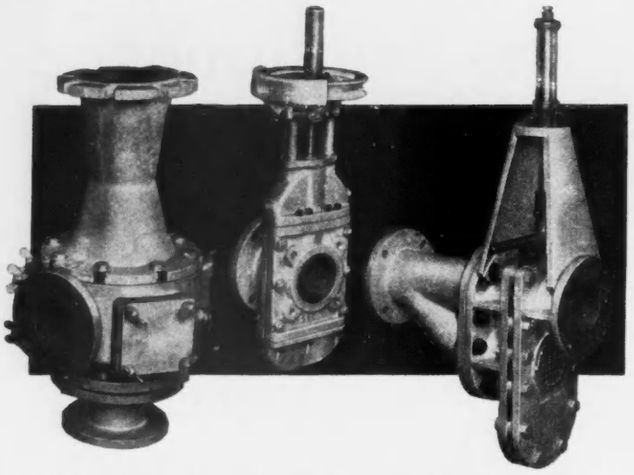

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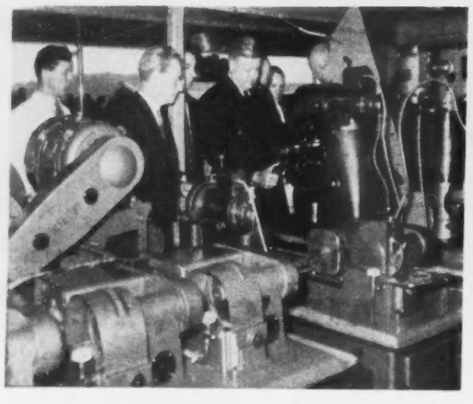

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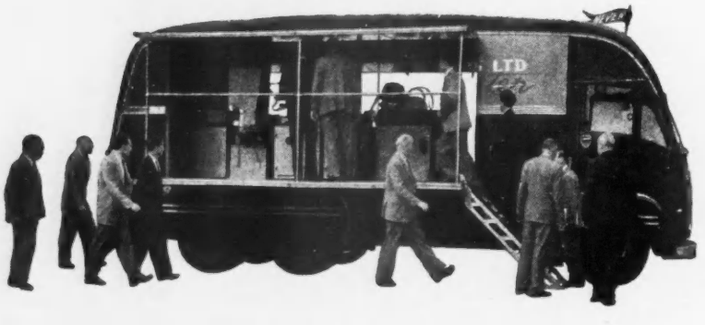

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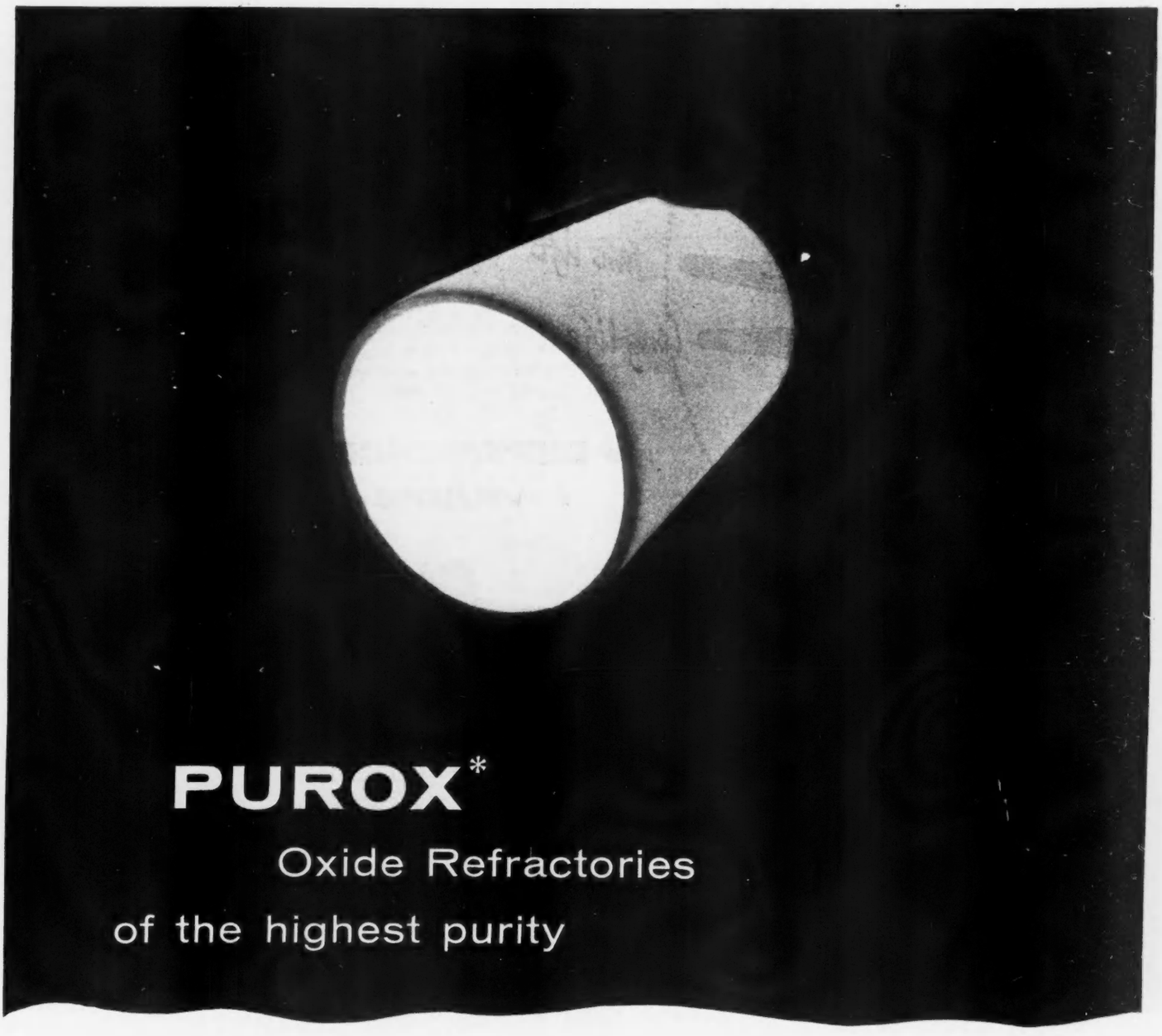

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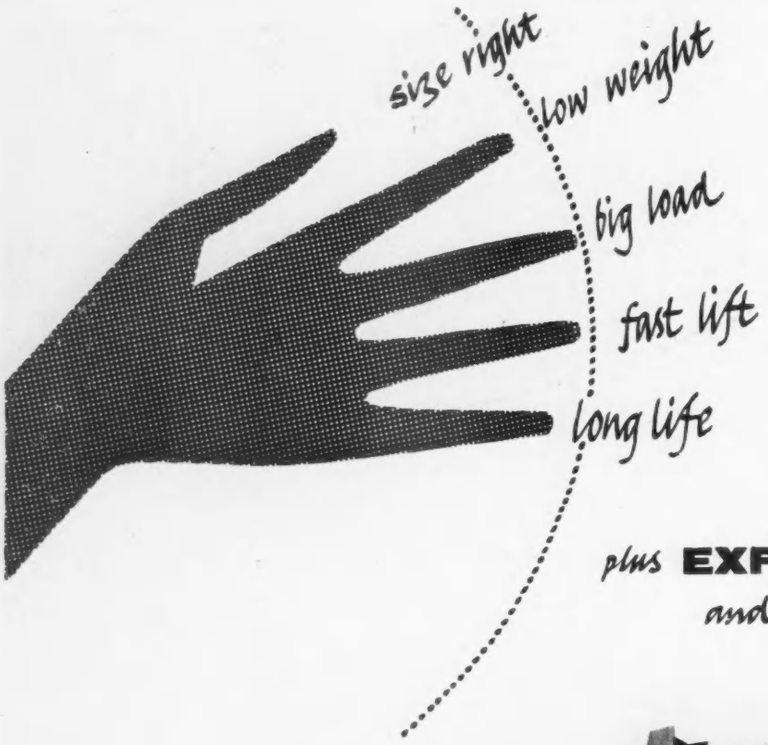

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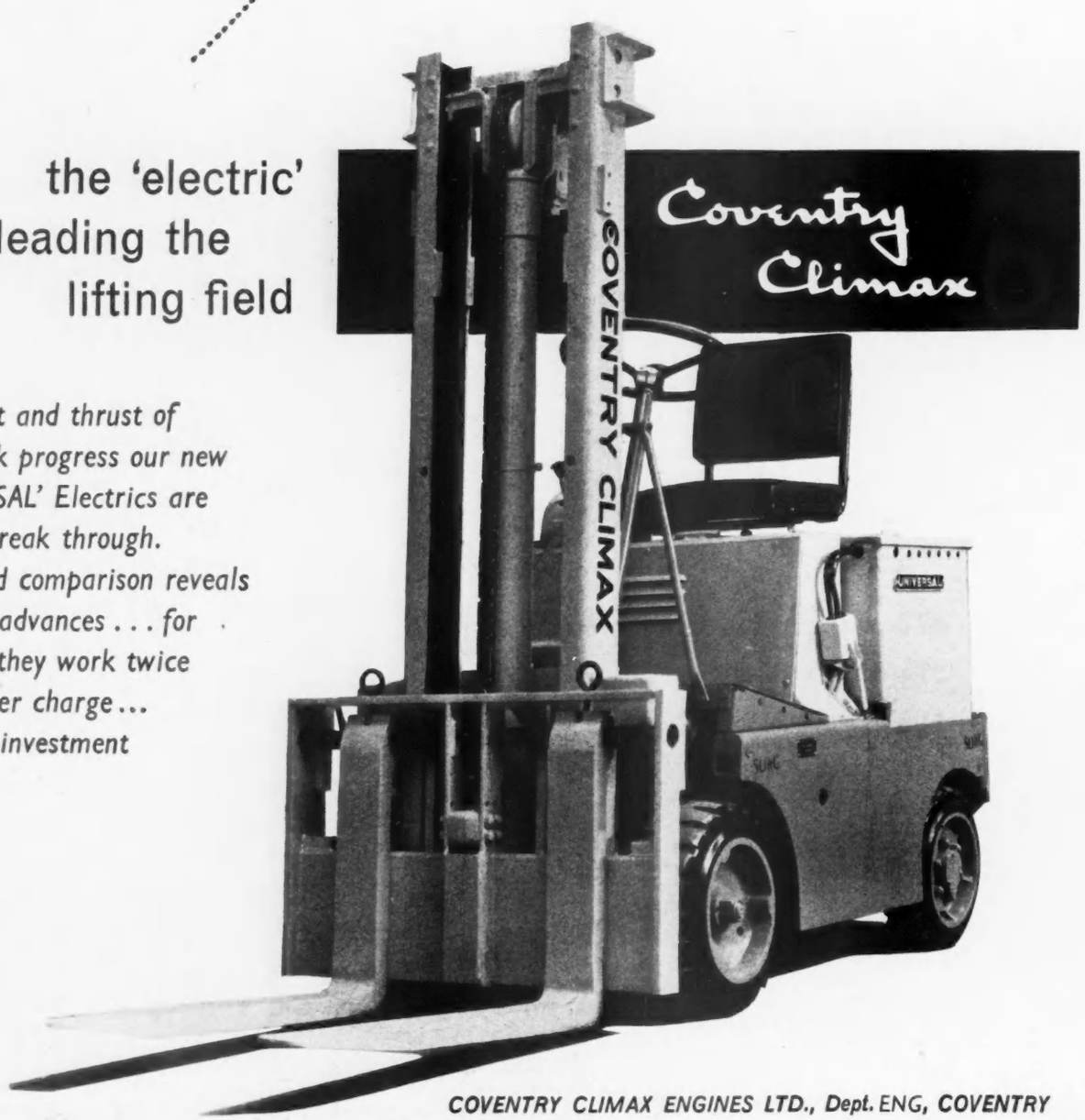

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THE ENGINEER

No. 5415 NOVEMBER 6, 1959 VOL. 208

M1

There was an atmosphere of proud achievement in the air at the Savoy Hotel on Monday, when the two main contractors for the new motorway threw a grand luncheon party to celebrate its opening. Only those with mud on their boots, who had personally laboured through the nineteen months gestation, could pass under that elegant concrete *porte cochère* with real pride, to enjoy their five courses and six speeches with the satisfaction of a job well and truly completed, a job which Mr. Watkinson asserted was a world record ! Indeed, it is the former Minister of Transport's own initiative that we have to praise for demanding the arduously short constructional period. On the four main contracts together, the contractor had to face a penalty clause of £40,000 per week should he overshoot the completion date. That sum was estimated by the consultants as a minimum rent for the road, i.e. it is worth about £3,000,000 per annum, and that is a measure of the saving in constructing it in two summers instead of three.

At this early stage in the national road programme, quite a lot of criticism of costs and methods is in evidence. Indeed, it is inevitable that major jobs will be a little more ragged now than after, say, five years of major construction. Improvement is to be expected as experience is gained, as it was in other major programmes such as the Scottish water power schemes for instance. It is therefore especially valuable to have the outstanding example of the M1 route at this stage as a yardstick against which future road schemes can be measured.

From the national, as against the technical point of view, however, we think the road may have even more significance. There is no doubt that it will prove a profitable investment (some economic facts will be published in THE ENGINEER next week) and it will save lives. These merits will be evident for the first time in this country at first hand. We therefore expect that as experience of the use of the road is gained, so will public pressure on the Government to undertake a really adequate road programme increase far beyond what has been the case up to now. We expect to see traffic build up on this road in excess of the estimates which have been made. Under these conditions, it would, in fact, prove even more profitable but its economic value would reach a peak only were it integrated into a network of motorways.

There are no outstanding works on the motorway in a purely technical sense—no long-span bridges and no elaborate methods of combating weak subsoils. Its problems were essentially problems of administration and planning accentuated by the short building period. Although the road follows a rural route, it passes through old-established and much used countryside ; dealing with " the people outside " apparently proved less tractable than engineering design, and will be more so in the future, since in the early days there was much scepticism about the actual construction of the road and consequently not much organised opposition. Indeed, we gather that Sir Owen Williams is still rather surprised to find that his excellent road has actually come into existence ! But realisation of the national need for such roads will, we confidently expect, offset this problem, and we may look upon M1 as the prototype of—to use Mr. Marple's words—" a road system worthy of the third quarter of the twentieth century."

Any criticism of the M1 route must necessarily be held in perspective against the long-overdue but nevertheless very welcome achievement of its completion. In what respect are there shortcomings ? Perhaps M1 might have been better named the " St. Albans to Dunchurch " motorway, for it does not reach either of the main centres. A journey from central London to the nearer end of M1 is likely to take as long and prove more exhausting than one along the whole length of M1 ! And especially for vehicles travelling south, surely the complex of dual carriageways which are not true motorways, at the south end, is likely to be rather confusing and dangerous ? Equally there seems little justification, either from a " common sense " appraisal or from perusal of the traffic studies, for the decision to build the south-west spur—the " Aldenham spur " or " Watford leg " as it is variously called, with merely a 24ft carriageway width, and not the 36ft width of the rest of M1.

URBAN ROADS IN WEST GERMANY

About a hundred delegates have just returned from a study tour, organised by the British Road Federation, of urban motorways in Western Germany. All that the delegates saw must surely reinforce the progressive view now gaining ground in this country, that the construction of adequate traffic arteries in large towns is a problem of great urgency and social importance. The study tour was noteworthy in a purely engineering sense. Many of the bridges and constructional works which were seen were technically first rate and of great interest to engineers. The real significance of the tour, however, lies, we think, in another direction, namely, in the appraisal it gave of the basic principles underlying these works, as they are applied by the West German authorities. First of all, the basic criterion is the traffic need, as determined by systematic traffic studies. Second, and this is where, time and again, the British visitors expressed themselves envious of their German counterparts, finance is on a scale commensurate with the problem. Thus an energetic programme of construction is going ahead, especially in and around the principal cities.

The British visitor to Germany is inclined to expect to find autobahns wherever he goes, and to consider them as pre-war semi-military feats of construction. This is rather misleading and the truth is not immediately

obvious that large-scale construction post-war, and indeed reconstruction of pre-war roads, has altered the picture very substantially. Pre-war autobahns were constructed clear of the towns, or just touching their outskirts. This is now recognised as mistaken policy, and present-day construction emphasises the urban motor road. Apart from a number of entirely new urban motor roads now under construction, where full motor road standards were not reached in earlier town road schemes, attempts are being made to improve principal routes to these standards. We hope to give some information on specific examples amongst these schemes in subsequent issues of THE ENGINEER. It should not be forgotten that the growth of the motor vehicle "population" of West Germany lags some years behind Great Britain and, new road construction apart, the situation would still not have reached quite the stage of congestion we have here. Nevertheless the urgency with which the problem is being tackled may be judged from the official announcement that, in West Germany, next year some £500 million will be spent on the roads. The corresponding estimate for this country (the populations of the two countries are near enough equal) is about £180 million, of which well under half is for new construction. If we assume (quite arbitrarily) that the same amount is being spent on maintenance in the two countries, then the West German programme of new roads would be five or six times larger than the British. The West German programme, incidentally, aims at a total of 2875 miles of autobahn, about double the existing total.

The British Road Federation's tour was well attended, principally by consulting engineers and by engineers and elected representatives of local authorities. The visitors were able to see the beginnings of the process of adaptation of the city to the motor vehicle, rather along the lines that we have been advocating in these columns. This process of evolution, as we have said before, is not entirely for the engineer to carry out, though he must delineate the skeleton of roads and solve the problems of their construction. Clothing the skeleton is a problem for the town planners, and particularly for architectural planning, and architects should be alive to the requirements and limitations, on the one hand, and to the imaginative possibilities on the other, of the motor-car city. Yet, disappointingly, the representation of architects on the Federation's visit was very slender.

EMPLOYMENT AND INDUSTRY

The latest unemployment figures issued by the Ministry of Labour show that, on October 12, the number of people registered in Great Britain as out of work represented approximately 2 per cent of the estimated total of employees. Thus, in considering the country as a whole, it can be claimed that a state of full employment is maintained. But over the last couple of years or so, a good deal has been said about those areas of the country in which pockets of local unemployment have occurred. The Government has, very properly, been concerned to find ways and means of alleviating local unemployment and, as was to be expected, the political parties gave an undertaking in their election manifestos that, if returned to power, this matter would receive immediate attention. Thus, it came about that on Wednesday of last week, the day after the new Parliament was opened, the Local Employment Bill was introduced in the House of Commons. The main provisions of the Bill are summarised on page 567 of this issue.

The principal object of the Bill is "to make provision to promote employment in localities in England, Scotland and Wales, where high and persistent unemployment exists or is threatened." In most respects it can be described as a "tidying up" measure for it endeavours to bring together and improve upon various enactments which have been devised in recent years to counter local unemployment. The Distribution of Industry Acts are to be repealed and three Industrial Estates Management Corporations—for England, Scotland and Wales—are to be set up to take over the functions of the five existing industrial estate companies. Much of the responsibility for administering the proposed legislation is to fall upon the Board of Trade which can acquire land, erect buildings and authorise loans and grants towards the capital cost of erecting or extending industrial premises in those areas where unemployment persists. On the other hand, the Ministry of Labour will authorise payments towards the cost of the removal and resettlement of key workers and the "appropriate Minister" is to be enabled to give financial assistance towards the improvement of basic services in a locality of high unemployment.

Undoubtedly, fuller details as to how it is hoped this proposed legislation will work will be revealed during the forthcoming debate on the motion for the second reading. As the national average unemployment is, at present, about 2 per cent, it is fairly generally assumed that the "localities of high unemployment" are those in which the figure exceeds 2 per cent. That means, according to the latest return, Scotland (4 per cent), Wales (3·4 per cent), Northern (3·1 per cent) and North Western (2·3 per cent). But since the beginning of this year, the Government has felt bound to make some additions to the list of areas qualifying for assistance under one of the Acts which it is now intended to repeal. Those additions included places like parts of Devon and Cornwall and parts of the coastal areas of Kent, Suffolk, Norfolk, Lincolnshire and Yorkshire, all of them areas in which there is but little in the way of industry and in which, consequently, employment prospects are shrinking. The provisions of the new Bill must take into account such places, as well as the traditionally industrial areas in which technological and economic changes may lead to a measure of redundancy and local unemployment. What the Bill now before Parliament attempts to do is to bracket local unemployment with the distribution of industry so that the Government's powers for assisting the solution of problems arising from both become more flexible than they were. The intentions of the Bill are undoubtedly excellent but, as we have already suggested, many gaps remain to be filled in. Local unemployment, like any unemployment, can be a sorrowful business but its alleviation may well depend on more than the building or transference of industrial establishments. The retraining of workers and the encouragement of greater mobility of labour do not get any specific mention in the text of the Bill. We recognise that they involve social as well as technical problems but we hope, nevertheless, that they will receive full and thoughtful consideration as the debates on these well-intentioned proposals proceed.

REPLACEABLE TREAD TYRE

There can be few automobile engineers whose imaginations did not quicken with interest at the recent announcement at the Turin show of a tyre with replaceable tread elements. Engineers in general, however, would do well to study the new design. For the automobile engineer the new product, supposing it to prove successful in practice, promises the solution of a number of problems.

No longer will it be necessary, for example, to store a large quantity of bulky carcases in order to mount eight wheels of equal size on a driven bogie, nor to carry two spare tyres on any vehicle so highly developed that the front and rear tyres cannot satisfactorily have the same treads. But those without the more specialised knowledge that allows fuller and deeper appreciation of the possibilities of this design—it adds to the fundamental attractions of metallic construction the ability to modify the tread when the limit of adhesion of even a rigid breaker tyre is reached—can still enjoy this new design as an example of what can be done to improve technically upon well-known devices. Few of us can fail to benefit by being reminded that it is long established practices that are particularly likely to fall short of the best attainable. Engineers in Great Britain, however, may be concerned to note that all the more recent major improvements in tyre design that have caused tyres no longer to be regarded as acceptable if they merely fit and retain air have originated overseas. No rigid breaker tyre has been sold in this country without either the name or the licence number of a foreign—if friendly and familiar—firm upon it. Those who are not satisfied to explain this fact by a series of historical accidents, and who choose to believe, as we do, that the Anglo-Saxon is just as well adapted to engineering as any other educated human, will wish to examine this effect critically to discern the causes. One cause, we suggest, is immediately apparent. It is that in this country standards of measurement for tyre performance are so little used and, possibly, so little understood, that even if an advanced tyre were designed here, its protagonist would be hard put to it to prove that it had any objective superiority sufficient to justify the final proof of practical trial. A number of organisations that utter pronouncements upon road safety seemed to have remained totally unaware that it is a part of the tyre that is invisible and difficult to inspect that determines the performance of the vehicle. The new tyre, a precision job by contrast with ordinary tyres in which tread and casing perforce use the same rubber and suffer the same curing process, conforms easily with the standards of the Society of Motor Manufacturers and Traders, since those " standards " place no tolerances on such easily measured quantities as size and out-of-balance. The final test is still to come. Will the new tyre find a market ? Its technical virtues are obvious enough. Will they outbalance any defects there may be ? We cannot tell. But we welcome the proof that evolution in the design of tyres is far from ended.

THE USE OF TECHNICAL LITERATURE

Since publishing on October 16 a note about a publication issued by the Department of Scientific and Industrial Research under the title of " The Use of Technical Literature by Industrial Technologists " we have been looking further into it. The more we look, unfortunately, the less impressed we become. To begin with the title is a misnomer. The sample consisted as to 61 per cent of people with no academic qualifications whatever ; and of a further 22 per cent only an unknown proportion were qualified to be members of an Institution of high merit. Thus it can be said of the sample that only 17 per cent were certainly of the quality to be associated with the description " technologist," though all were active within a technology. Upon the basis of so varied a sample whose one thing in common was employment in the electrical industry, to which the survey was confined, a number of conclusions are drawn. Admittedly they are drawn rather guardedly. The primary purpose of the inquiry is stated to have been to obtain readership statistics for technical and trade journals read by technologists in the electrical industry. But the value of any conclusions drawn is largely vitiated by the nature of the sample.

Quite a lot of attention, we expect, will be attracted by a table in the publication which lists a variety of journals by the number of those interviewed who see the journal regularly, read or scanned it in the last year, or made it their choice if three journals only could be taken. In all three lists THE ENGINEER takes a remarkably high place considering that it is not a specialist electrical journal, It comes tenth, sixth and seventh in the respective lists and in all cases the higher places are all occupied by electrical journals save only one in each column—the same one—about which a doubt exists, as, unfortunately, no distinction was drawn between a British journal and an American one of the same title. We do wish we could take real satisfaction in that result. But we cannot. For the method of sampling necessarily favoured a less highly specialised journal such as ours outside the electrical field, which, however, still covers electrical engineering.

If those who carried out this survey really want to find out how satisfactorily or otherwise technologists make use of the literature we do suggest that a more suitable sample be selected. The sample of real technologists covered by this survey is too small for any really reliable conclusions to be drawn.

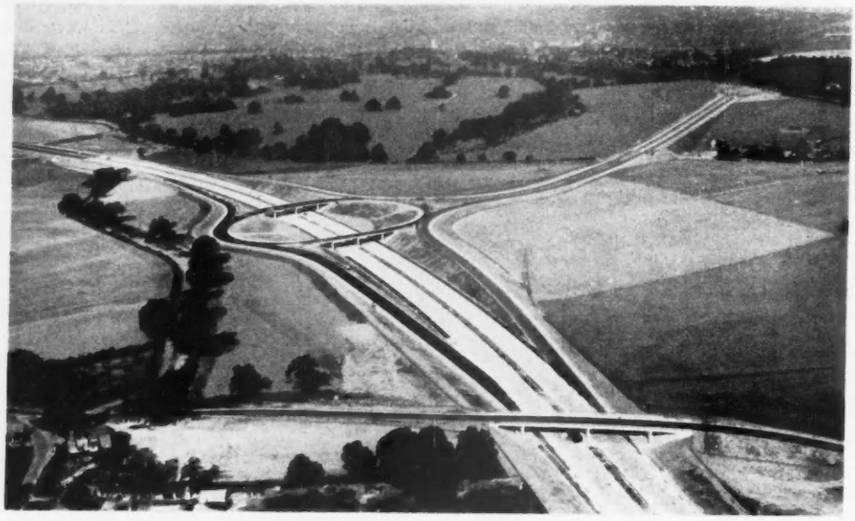
The Engineer—100 Years Ago (NOVEMBER 4, 1859)

" IRON VESSELS."

" Although a ship may not be built for the purpose of being dashed upon the rocks, that is a risk which it must incur every time it approaches a rocky coast. With a wooden vessel, to strike and to go to pieces are almost one and the same thing ; but we have had many proofs that iron hulls can successfully resist shocks which would almost instantly break a timber ship in two. The Royal Charter has been lost under the most appalling circumstances ; in the first place, because she struck the coast ; in the next place, because she was not strong enough to resist the shock. Her striking might have been unavoidable ; her breaking up might have been otherwise. From the former universal distrust of iron ships we had come to look upon them as almost invulnerable, and such a loss of a large modern-built iron steam vessel strikes upon as would the breaking down of the Britannia Bridge under a heavy train of human freight—almost, indeed, as would the report of the fall of St. Paul's upon a compact crowd of the people of London.

" We have been building great numbers of iron vessels during the last few years. Are we, after a few years' service from them, to have a crop of such terrible disasters ? . . . If such results are in store for us, the sooner a complete revolution is effected in our system of iron shipbuilding the better. Such a loss as that of the Royal Charter, is unquestionably in the category of ' preventible disasters,' and we should not rest satisfied until by conscientious care in the manufacture of plates and rivets, and in our modes of combining them into ships, we have attained the greatest strength of which such constructions are capable."

London to Birmingham Motorway—No. I



This country's first major length of motor road was opened by the Minister of Transport, Mr. Ernest Marples, last Monday. The M1, as this route is called, has dual three-lane carriageways, reducing to dual two-lane carriageways on the two spur roads at the southern end and at the Dunchurch spur at the northern end. The total length of motorway is about 75 miles.

BY the time that this article is published, most readers will have seen the reports of the daily newspapers on the opening of Britain's first major motorway, and indeed, some will have had an opportunity to drive along it, and gain a first-hand impression of its capabilities. Here we try to give some idea of the engineering aspects of its construction, and later on, an appraisal of the economic benefits which it will give, and the savings in accidents resulting from its use.

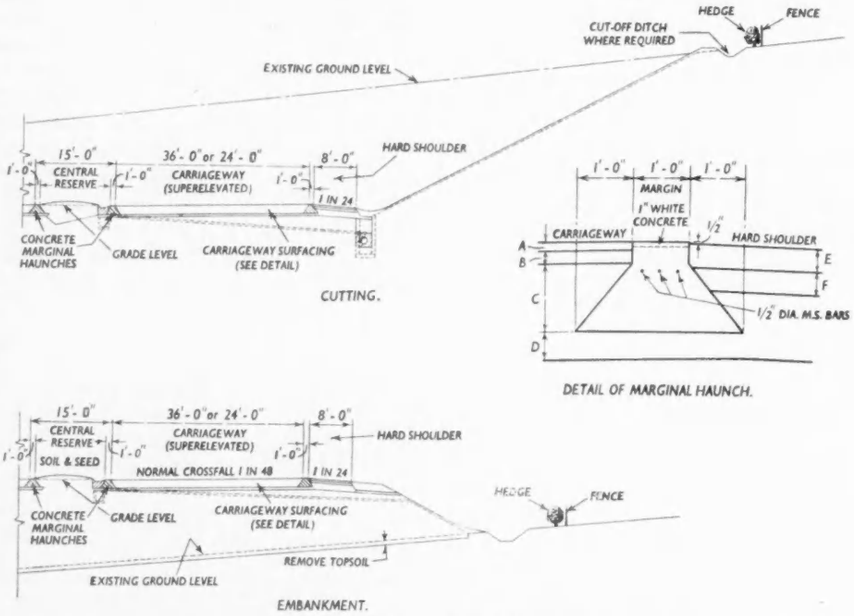
There can be no doubt of the importance, from a national point of view, of this new road, which is, in 1959, the first road in the country* designed to suit contemporary vehicles and speeds. Furthermore, the construction of the main length of road in the short period of nineteen months is a fine advertisement for the capabilities of British civil engineering. The last year or two apart, the post-war period has been rather devoid of the spectacular, as far as civil engineering works have been concerned, due, of course, to the financial and economic background which has held up works such as large bridges. Now that a sizeable road programme is getting under way, it is particularly heartening to see the first major objective of this programme achieved so speedily and expeditiously. We cannot recall another job of this size completed in Britain in such a short period since the war, and indeed, Mr. Harold Watkinson, the former Minister of Transport and Civil Aviation, referred to it in his speech last Monday as a world record.

The accompanying maps will give a good idea of the route taken by M1, and of the spur motor roads and the dual carriageway roads associated with it. The overall responsibility for the engineering practicability of this complex of road schemes has rested with the Ministry of Transport and Civil Aviation (chief engineer, Mr. J. F. A. Baker, M.I.C.E.), which initiated the scheme as a whole, and which has also been responsible for much administrative detail, including land acquisition. The consulting engineers, Sir Owen Williams and Partners, designed and supervised the construction of the main 55-mile stretch from north of St. Albans to Crick and Dunchurch, which has been carried out by one contractor, John Laing and Son, Ltd.

Sir Owen Williams and Partners were also responsible for some of the bridgework on the St. Albans by-pass section which was otherwise designed by Hertfordshire County Council (county surveyor, Lieut.-Col. C. H. ffolliott, M.I.C.E.). The 12-mile section of this by-pass, from just north of the Bedfordshire boundary to Park Street, was carried out by Tarmac Civil Engineering, Ltd., and the Aldenham spur by a consortium of companies, Cubitts, Fitzpatrick, Shand.

Warwickshire County Council (county surveyor, Mr. D. Watson, M.I.C.E.) was responsible for the Dunchurch by-pass motorway, which was constructed by A. Monk and Co., Ltd.

The most noteworthy aspect of this organisation was the construction of the main length of the motor road by one firm of contractors only, responsible to one consulting firm. About 53 miles of motorway was advertised for tender in four approximately equal lengths, and alternative constructional periods covering two or three summers were stipulated. In the event, all four contracts were awarded to the one

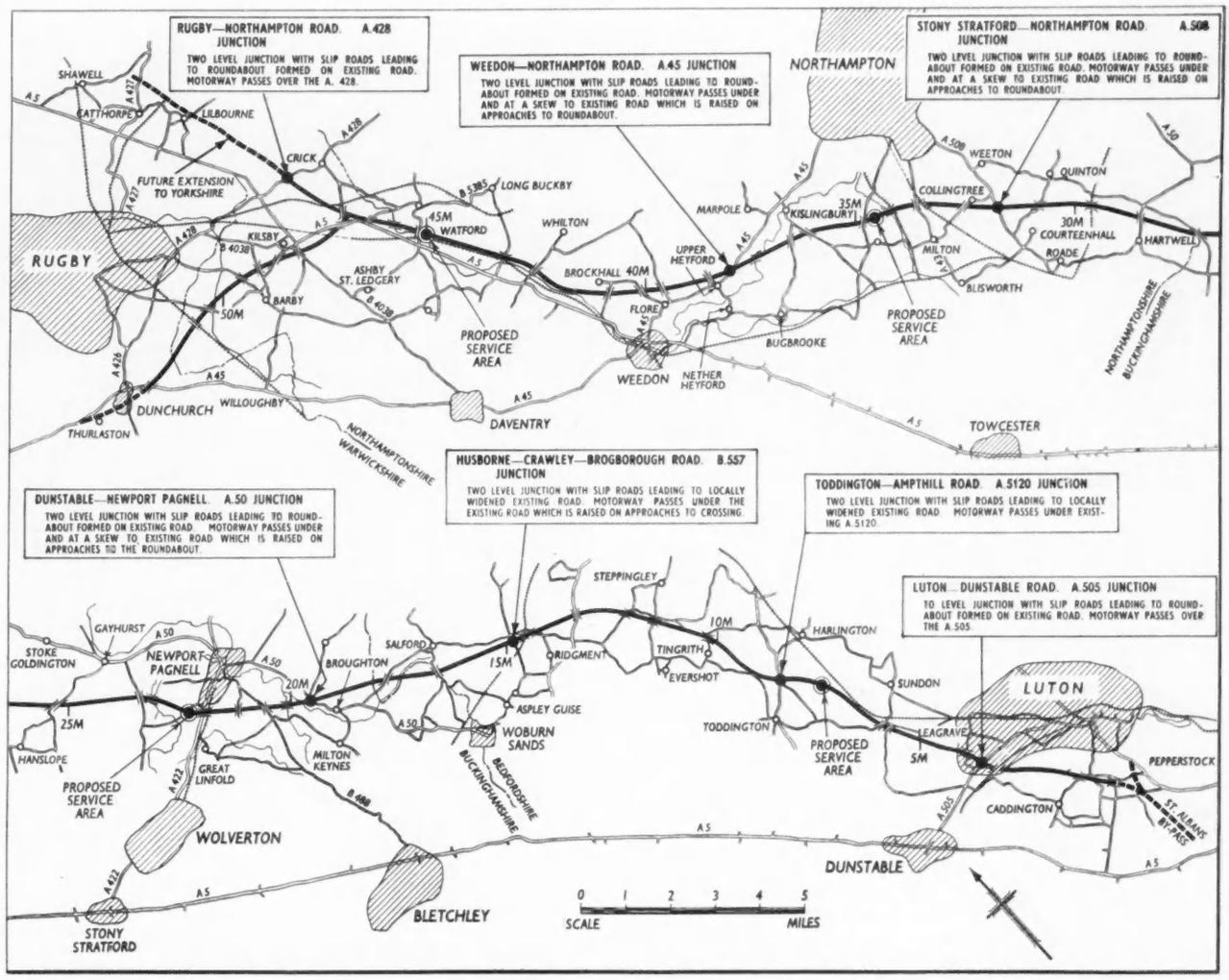


Carriageway :
A—Wearing Course.—1½in hot rolled asphalt, B.S.S. 594 : 1950. 55 per cent igneous stone as Table V, Schedule 1 and Binder as Table I, Column 3.
B—Base Course.—2½in hot rolled asphalt in single course material, B.S.S. 594 : 1950. 70 per cent igneous or calcareous stone as Table XI, Schedule 4. Binder, Table I, Column 1.
C—Lean Concrete Granular Base.—20 : 1 mix by weight, 14in thick, surface treated with rapid breaking 55 per cent bitumen emulsion and blinded with sand.
D—Granular Sub-Base.—Compacted thickness 6in. Surface treated with tar or bitumen binder and blinded with ⅜in chippings.

Hard Shoulder :
Hard shoulder sanded and sprayed with approved bitumen emulsion and rolled with a spiked roller.
E—4½in gravel-sand-loam mixture, fertilised and sown with grass seed (30 square yards per pound).
F—4½in crushed stone or gravel base.
Marginal haunch :
Concrete.—Minimum cement concrete—21 lb per cubic foot finished concrete.
Coarse aggregate maximum size 1½in.
White Concrete.—Coarse aggregate maximum size ⅜in crushed calcined flint. 1in thickness laid simultaneously with ordinary concrete.

Typical constructional details, in cutting and on embankment respectively, for the main length of the M1 route. Note the concrete haunches which contain the carriageway construction and the use of dry lean concrete with a "black top"

* Excepting only the 8-mile Preston by-pass. See THE ENGINEER, December 12, 1958.



Route of London-Birmingham motorway. Details of roads at the southern end are shown in the second map. At the northern end, the easterly spur ends at Crick, where there is a connection to the A5 road ; this spur will eventually continue the motor road to Yorkshire. The western spur runs into the Dunchurch by-pass motorway, at the eastern end of which the motorway ends at a large roundabout. There are, however, newly-constructed dual carriageways on the A45 as far as the outskirts of Birmingham

firm, for the shorter period. Organisation of the other related roads was co-ordinated with this programme. Later on, a section of motorway nearly 2 miles long, leading to Crick, was added to this main length, making a 55-mile stretch, the estimated cost of which is about £16,500,000.

At the southern end, the 12-mile length of the St. Albans by-pass, constructed to the same time scale, is estimated to cost about £6,500,000, and the 5-mile Aldenham spur just under £1,500,000. Work started later on this spur road (in May, 1958) than on the other schemes, but its construction is now ahead of schedule, and it was opened as far as the Waterdale interchange, last Monday. The remaining length is expected to be open within a month. At the northern end, the Dunchurch by-pass motorway has been built for about £400,000. It is about 2 miles long. Thus, the total cost of approximately 75 miles of motorway is in the region of £25,000,000.

The present stage of progress with the dual carriageway roads associated with the southern end of the motorway route is indicated in the caption to the second map. The London Colney by-pass—the only one completed—was built to the design of Mr. ffolliott and his staff by John Laing and Son, Ltd.

At the Birmingham end of the motorway further constructional work on the A45

TABLE I—*Principal Statistics for the London-Birmingham Motorway*

Length of motorway	55 miles
Number of bridges	131
Number of culverts	92
Two-level junctions with existing roads	6
Realignment of existing highways and their services	17 miles
Land acquisition :	
Frontage	150 miles
Land plans	15,000
Percentage division of total work :	Per cent
General	8·0
Site clearance	0·3
Hedges, fences, trees and shrubs	3·0
Drainage, including culverts	6
Earthworks	25
Surfacing	35
Structures	20
Dayworks	2·7
	100
Approximate overall quantities :	
Bulk excavation	11,000,000 cubic yards
Road works :	
Granular and approved filling	1,100,000 cubic yards
Crushed stone and gravel	66,000 cubic yards
Lean concrete for motorway	800,000 cubic yards
Reinforced concrete for marginal haunches	113,000 cubic yards
Kerbs	69,000 linear yards
Surfacing :	
Base course	2,500,000 square yards
Wearing course	
Bridge works :	
Concrete piles	3,000
Excavation, foundation pits and trenches	172,000 cubic yards
Mass concrete	136,000 cubic yards
Reinforced concrete	146,000 cubic yards
Steel for reinforced concrete	12,000 tons
Cement	100,000 tons

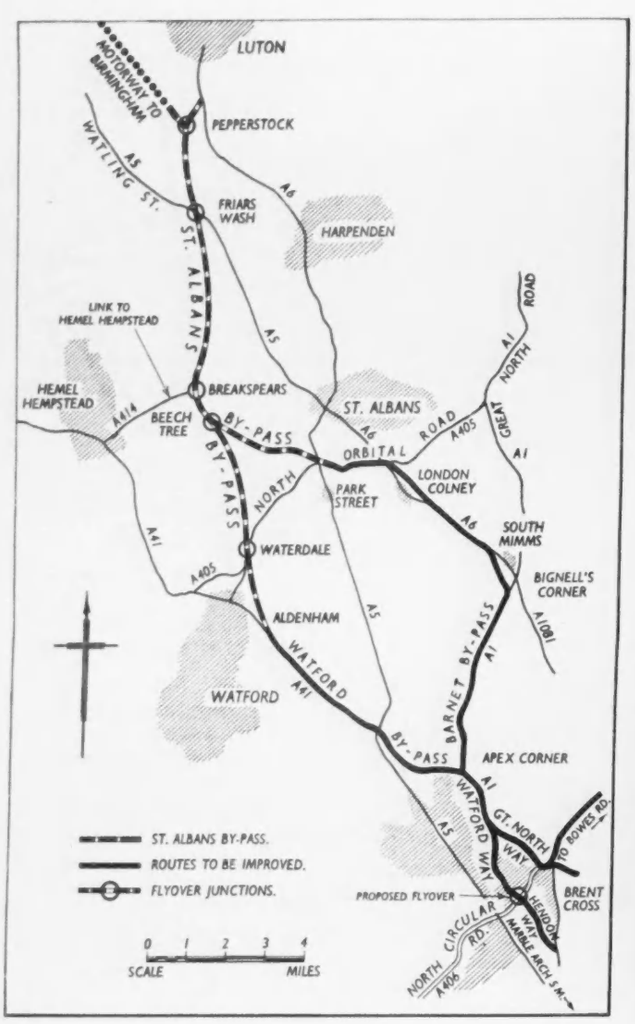
Plant on the site included the following : 95 scrapers (48 rubber-tyred, 47 tractor) ; 182 miscellaneous excavating machines, face shovels, back acters, &c., ranging from 10–54 R.B.s. ; 6 derrick cranes ; 89 bulldozers ; 18 piling rigs ; 54 Euclid trucks ; 242 ordinary lorries ; 12 pneumatic-tyred rollers ; 6 sheepsfoot rollers ; 54 smooth wheel road rollers 6/10 ton ; 28 graders ; 1 Euclid loader ; 18 pavers ; 112 concrete mixers from 10/7–21/14 ; silos and batching plants.

gives dual carriageways (not motorways) from the end of the Dunchurch by-pass to the outskirts of Birmingham. This work was also under Mr. Watson's direction, and includes a stretch from the Dunchurch by-pass to Stretton-on-Dunsmore, also built by A. Monk and Co., Ltd., and extensive work on the Meriden by-pass done by Tarmac Civil Engineering, Ltd.

Our first illustration on page 544 gives a good idea of the appearance and construction generally characteristic of the M1 route ; it shows the Pepperstock interchange. In the background, the " black top " carriageways of the main length of motorway commence, the works in the foreground, characterised by concrete carriageways, all being part of the St. Albans by-pass. In the centre is the raised roundabout from which the short Luton spur leads to the A6 road. The roundabout on the right is the " terminal " of the motorway spur at A6. The bridges shown are of the Hertfordshire County Council's design.

THE MAIN 55-MILE LENGTH

The motorway has been referred to in these columns on about a dozen occasions already and in interim notes published during the constructional period we have stressed the extreme rapidity of progress, the vast quantities of materials involved, and the site organisation needed to cope



(Left) Roads at the southern end of the motorway. The St. Albans by-pass motorway is complete, except for the length from Waterdale to Aldenham, which will be opened in about a month. To the south is the proposed complex of dual carriageway (not motorway) routes, of which the London Colney by-pass is built, and a second carriageway is under construction on contiguous lengths of the North Orbital road and A6. An urban motorway is being studied from Brent Cross to central London. (Right) A typical length of the main stretch of motorway where it passes to the north of Dunstable, Bedfordshire

with the programme. These aspects will not, therefore, be stressed here. An outline of the major design features may, however, be usefully given.

The drawing on page 544, gives typical cross-sectional details, and in the legend further data for the carriageway and hard shoulder construction are given. Like all the main road schemes, Ministry of Transport specifications dominate the design. The following are the principal standards embodied in the road :

(*a*) Design speed, 70 m.p.h.

(*b*) Minimum horizontal curve 2865ft radius. Radii of curves are generally greater, in the order of 10,000ft or over. Transition curves are used on horizontal curves of less than 6300ft radius.

(*c*) Super-elevation is applied where the horizontal curves are less than 11,400ft radius.

(*d*) Minimum sight line, 750ft, but generally not less than 1000ft, based on 3ft 9in height of driver's eye to 3ft 9in height of object.

(*e*) Motorway maximum gradient 1 in 30, but generally flatter than 1 in 50. Slip road gradients at the junctions are 1 in 30 except for the Luton–Dunstable A.505 junction which is 1 in 25.

(*f*) Loading. The motorway carriageways and bridgeworks are designed to full Ministry of Transport standard loading and will carry abnormal indivisible loads. Farm access and accommodation bridges are designed for half the standard loading.

(*g*) Minimum vertical clearance, 16ft 6in to the full width of carriageways and hard shoulders of motorway and over carriageways of existing highway.

As far as possible a " flowing alignment " has been sought, by fitting in the road to the landscape, and co-ordinating horizontal and vertical curvature. The minimum formation widths are 112ft and 88ft respectively for 36ft and 24ft carriageways, allowing 3ft 6in outside the hard shoulder and a 15ft central reservation. Side slopes of cuttings and embankments are generally 1 in 2 (1 in 3 at flood plains). Generally, cuttings and embankments do not exceed 25ft in depth, but there are a few cases of depths in the 35ft–40ft range.

Drainage

Surface water from the carriageways, hard shoulders, &c., where the motorway is in cutting flows to longitudinal channels formed in the verges or in the central reserve where carriageways are super-elevated. These channels discharge to storm sewers via catchpits at 360ft centres.

The storm sewers are in the verges at the toes of cut slopes and are formed by jointed pipes surrounded with concrete ; they are surmounted by 6in diameter french drains for slope drainage. Where necessary additional slope drainage is by herringbone systems. The storm sewers in cuttings discharge to longitudinal channels formed at the toes of the embankment slopes. The surface water from embankment sections flows over the hard shoulders, verges and embankment slopes to the channels at the toe. Discharge from these channels is to natural water courses.

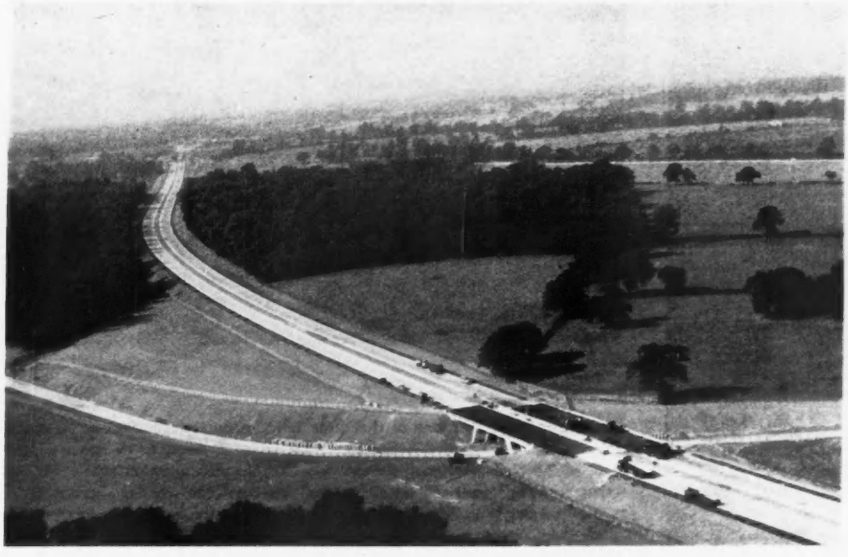
Where required sub-soil drainage below formation is provided by herringbone drainage systems, this method in conjunction with deepened side drains being particularly suitable to deal with poorly drained silty materials in cutting sections. Storm sewers are designed for a " one year " storm and the channels in cuttings provide additional capacity such that a " ten year " storm will not cause flooding on the carriageways.

Cross drainage, comprising all those works necessary to maintain the general pattern of natural drainage, includes the provision of culverts, stream diversions and the maintenance of existing land drainage systems. Catchment area plans were prepared for all stream crossings, and calculations of peak flows (including motorway run-off) made for a " twenty-five year " storm frequency, for which all culverts were designed. To give free access to culverts under the motorway, the minimum size is 3ft 6in diameter.

(*To be continued*)

St. Albans By-pass

On the main 55-mile length of motorway there is a two-level junction where the Dunchurch spur bifurcates, and there are terminal junctions at the two northern ends. Apart from the terminal points, motorists can enter or leave the motorway only at six "interchanges." By contrast the St. Albans by-pass is more complicated. It is only about 12 miles long plus a 5-mile spur to Aldenham, but has three terminal junctions (one on the short spur road to Luton) the analogous junction where the Aldenham Spur bifurcates from the eastern spur and four intermediate "interchanges."



The UPPER VIEW shows the Beechtree junction where the by-pass divides. The Aldenham spur (it is also called the "Watford leg") runs up the centre of the illustration, and the eastern leg (which terminates at the junction of Park Street and the North Orbital Road) comes in from the right. Note that these are both dual two-lane roads, but to the north of the junction the road has dual three-lane carriageways. The road crossing over the motor road is the A414 from St. Albans to Hemel Hempstead. The motorway bridges shown are of the so-called "universal" design as used by the consultants on the main section of the motorway to the north.

The CENTRE ILLUSTRATION shows a typical length of the St. Albans by-pass motorway between the start at Park Street and the junction illustrated above. The concrete carriageways, with flexible construction interposed at the underbridge, are well shown. This bridge, with the sloping legs, is one of the Hertfordshire County Council's designs.

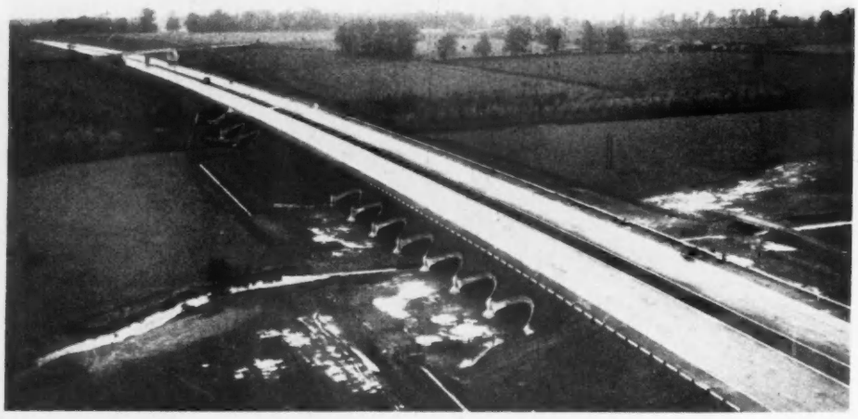
In the LOWER VIEW we show the interchange at Friar's Wash. There is no full clover leaf junction anywhere along the entire route, and the typical "interchange" might be considered to be a roundabout, above or below the motorway level, on the subsidiary road, with slip roads to and from the motorway. The Friar's Wash interchange is to a different layout, with the A5 passing without interruption under the motorway, and the slip roads forming a modified clover leaf pattern. The bridges seen here are both "consultants" and "county council" designs.

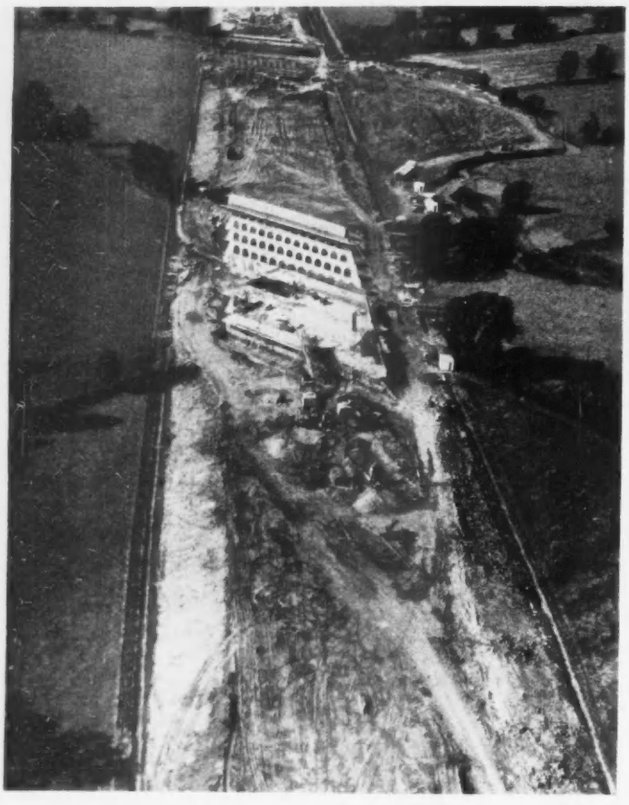
Motorway Viaducts

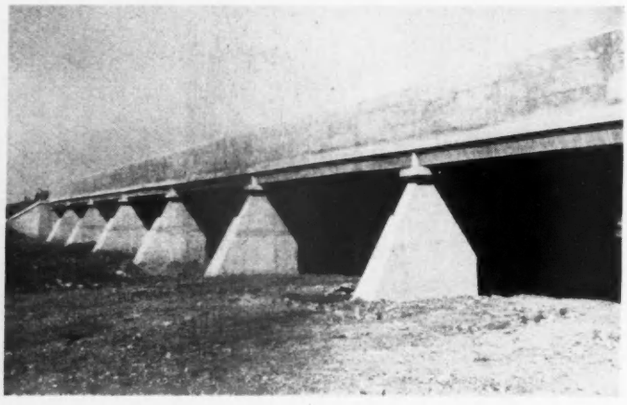
The motorway has three viaducts forming river crossings over the rivers, Great Ouse, Nene, and Lovat (or Ouzel). On the RIGHT is the River Ouse viaduct, north of Newport Pagnell. Its construction typifies the designs evolved for rapid construction, with emphasis on a sequence of relatively simple and straightforward operations on the site. The basic element is a three-pinned arch in unreinforced concrete. Above the arches is simply earth-fill carrying the carriageways.

It will be seen that there is a viaduct for the river itself and a secondary viaduct with flood arches in the foreground.

The arch construction of the Ouse viaduct demands a greater depth of construction than was available at the Lovat and Nene crossings.

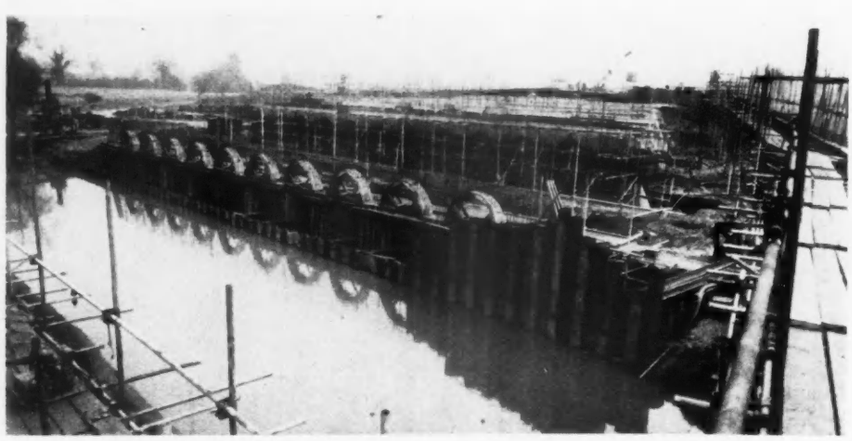






We illustrate ABOVE one of the three Lovat viaducts just south of Newport Pagnell, and LEFT and BELOW two constructional views, taken about a year ago, of the Nene viaduct (near the A45 Northampton/Weedon road). These structures are "wall and slab" designs. At the Nene crossing there is again a river opening and a relief channel close to it. Over the main river the concrete deck slabs are carried on ten piers each 120ft long. The square span at the river crossing is 56ft between piers, and the remaining ten spans are each of 28ft. The deck slabs are 1ft 9in thick, with the exception of those on either side of the long span. These slabs are 3ft thick, and 14ft long cantilever slabs of this thickness were built out over the river. Then a 28ft slab over the river was carried on the cantilevers. Mass concrete footings down to 15ft below ground level support the reinforced concrete piers which taper in section from 2ft 10in to 1ft over a height of 16ft. There are arched openings in these piers for weight reduction. The relief viaduct is similar in detail, with nine spans of equal length. Although the river and stream are small these long viaducts have been necessary to span the flood plains on either side. They have lengths of 376ft and 357ft respectively.

The illustration on the LEFT shows the piers of the southern viaduct under construction together with adjacent lengths of motorway. The LOWER view shows piers at various stages of construction with a steel-sheet-piled cofferdam enclosing the river pier in the foreground.



Institution of Civil Engineers

On Tuesday, November 3, the new president of the Institution of Civil Engineers, Mr. Arthur Clifford Hartley, C.B.E., delivered his presidential address. He spoke of the history, and of recent technical developments in the oil industry, and commented on the views expressed by certain of the Institution's former presidents in their addresses. The concluding section of Mr. Hartley's address is reproduced hereunder.

It should be realised that there is a difference between the processing field and the classical civil engineering field in that the product of the processing industries is not an engineering one. It is not fully realised among civil engineers what fascinating opportunities there are in the field of these industries, but it is certain that in the long run the country's success or failure will depend on the ability of the processing industries to hold their own in world markets. The techniques which go into all types of modern plants become ever more complicated and there is a most urgent need for a sufficiency of engineers for the processing industries who can ensure that plants are designed, built, and maintained in a manner which allows their products to be competitive with other countries. If engineers are not forthcoming to direct the engineers who are carrying out this work, accountants and administrators will take control and it will, I am sure, be agreed that this is not in the best interests of industry.

Thirteen years' experience in building the Industrial Group of the Atomic Energy Authority up to twenty-two senior professional staff and 250 other professional staff has shown that engineers, and particularly civil engineers, do not appreciate the full life which the processing industries can offer them, and that over-specialisation is taking place without sufficient regard as to how the work of the specialists can best be directed.

During the past few years the oil industry has collaborated with the chemical industry to form the petroleum-chemical industry which produces solvents, detergents, plastics, synthetic fibres, synthetic rubber, fertilisers, insecticides, and many other products, including a whole range of pharmaceutical products. Here again there is the greatest need for engineers to fill the senior positions.

The Institution in the past has been abreast of all modern developments by revising the education and training requirements and by ensuring that membership of the Institution qualifies an engineer to play his full part in civil engineering work of all kinds.

Coming now to the future, we hope that there is a long period ahead of us of world-wide peaceful development, in which great civil engineering works will be required and in which many of our members will participate, but it is apparent that they will meet increasing competition from the engineers of other countries. In addition to these works we have seen that the oil and processing industries generally have become, during the past few years, of vastly increasing importance. For instance, the expenditure of the oil industry in the next ten years is likely to be double the expenditure of the past ten years, and to reach the gigantic figure of £50,000 million. There will be a most urgent demand not only for engineers of all branches to use their specialised experience, but also for highly qualified engineers with initiative and imagination, who will take the keenest interest in the industry in which they are working and become its organisers, leaders, and controllers.

Unfortunately this demand is being met far better in the United States of America and Russia than in the United Kingdom, and recent official and other reports show that America is training scientists and technologists at more than three times and Russia at about ten times our total annual output. The rate per 10,000 of the population is given as 6·0 in Russia compared with 3·75 in the United States and about 3·0 in Britain. There is no doubt about the quality of the Russian engineers, particularly in the higher grades.

Professor Pippard, in his presidential address a year ago, focused attention upon the inter-relationship of the Institution, the individual and the profession, and pointed out that in addition to the inspiring achievements of British civil engineering during the past two centuries, there had been, particularly during the past century, equally notable achievements in mechanical, electrical, and chemical engineering, which had led to the engineering profession becoming divided into powerful component bodies, and it appeared at one time that the separation might be complete and final. He continued : "... but with the widening horizon of both science and engineering, there is perforce a steadily growing appreciation of the fact that engineers of all persuasions must work in the closest collaboration, not only with one another but with scientists, if the fruits of knowledge are to be garnered for the betterment of the world."

The Institution has for many years worked very closely with her sister Institutions, the "Mechanicals" and the "Electricals," and more recently also with the Institution of Chemical Engineers and the Institute of Physics in the British Nuclear Energy Conference, and still more recently in the creation by some forty constituent Institutions, Institutes, and Societies of the British Conference on Automation and Computation.

I was pleased to read the presidential address of Sir Willis Jackson delivered to the Institution of Electrical Engineers last month, in which he referred to encouraging with early enthusiasm and with satisfying recognition and support the initiative and vitality of those associated with new developments and so keep them within the present Institutions. I am sure the other Institutions are in full agreement with Sir Willis.

By co-operation and by as much unification as is possible, we shall be able to exert a still greater influence on education and training and ensure that engineering, and in particular civil engineering, attracts men with first-class brains and ability so that vast engineering works can be successfully completed in the years to come. I think this is a far better way of acquiring status than by compulsory registration which is being discussed from time to time here and in other countries.

The Institution is giving much thought to the possible ways in which it can best apply the fruits of its great achievements, traditions, and experience alongside our sister Institutions in ensuring an adequate supply of the leaders now so urgently required in the engineering profession. As I have already remarked, if they are not forthcoming the work of our members will become specialised and will be directed by members of other professions.

One wonders if the rapid developments during recent years have not resulted in far too specialised courses in the universities and technical colleges, and whether these do not tend to damp down initiative and imagination and to limit a wider interest in the arts and humanities. There is probably not much that can be done in the courses themselves, but the students, undergraduates, graduates, and young engineers should be encouraged to take a keen interest in affairs around them. Reference has been made to societies like the Royal Society of Arts, and I know that engineers who take part in their activities derive great benefits from them.

Assuming that we can produce the number and quality of engineers required, it is vitally necessary that those engineers at all levels who first employ them, should see that they are employed on work which they are just, and only just, capable of undertaking, and then give them the benefit of good leadership and encourage them to use their imagination and initiative to the full.

I would now like to mention another aspect of future engineering. The world-wide competitive position British engineers are now meeting makes desirable a consideration of whether they are being employed to the best possible advantage in the national interest from the point of view of winning large overseas contracts. Chiefly since the war, and in an attempt to meet similar overseas competition, there has been a greater tendency for British contractors to adopt the "package bid" system, in which each firm prepares a design on a competitive basis and includes it in the estimated price for the completed work. These designs and bids have then to be compared and approved by the client's own engineers or by consulting engineers employed by him for the purpose. Only one design can be accepted and the work and cost of preparing the other designs is wasted. The tendency towards "package bids" appears recently to be reversing and, as an example, reference may be made to the decision of the World Bank not to allow the same firm to do consulting and construction on the same scheme. They must elect to do one or the other. In my earlier quotation from Sir Alexander Kennedy's address of 1906 you may remember he deprecated the package bid and I put forward the thought that perhaps to-day design engineers might be better employed with the clients or with consulting engineers in the more traditional way.

Sir William Halcrow, in his address thirteen years ago, said that the Institution, far from being a decadent body, was the active leader of engineering professional organisations. In his concluding remarks he said : "... let us all envisage the future as one of unlimited opportunity for useful work in the interest of the good of mankind the world over. The Institution has already taken a part and can in the future take a large and increasing part in this great work ; I am convinced," he went on, "that the well-being and usefulness of the profession as a whole will be increased by co-ordination of activities and fuller co-operation with other Institutions, and, let us hope, by appropriate amalgamations." I think it can be claimed that the Institution has shown no sign of decadence during the past thirteen years.

New Car Ferry "Freshwater"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

With the increase in the number of cars produced there would appear to be a commensurate number of owners who wish to leave the country and the new car ferries which have been built recently for service to the Continent have already been described in these pages. A similar state of affairs is found in connection with the carriage of cars to the Isle of Wight. There are three main routes, two operated by British Railways, these being from Portsmouth to Fishbourne, and Lymington to Yarmouth, while the third is maintained by a private company with sailings between Southampton and Cowes. The new car ferry described has entered service. She has Voith-Schneider propellers.

Fig. 1—Passenger and motor-car ferry "Freshwater" on her sea trials—1959

WHEREAS from the start the ships employed on the Fishbourne route to the Isle of Wight operated by the Southern Railway were built specially for the work, the private Southampton to Cowes company for many years was content with carrying cars on the fore main deck of its passenger paddle steamers. A barge towed either by a chartered tug or one of the Southern Railway paddle steamers conveyed cars on a third route to the Island from Lymington to Yarmouth.

In 1937 important work was undertaken and slipways were finished both at Lymington and Yarmouth with a view to cars driving straight on to a double-ended vessel, and leaving direct from the other end. For this purpose a very interesting vessel appeared, for "Lymington" (Fig. 2) was driven by Voith-Schneider propellers, which were able to impart to her sideways motion as well as the usual direct fore and aft motion. This soon gave her the nickname of the "crab boat." It is interesting to record that in the same year (1938) "Vecta" another Voith-Schneider ship began sailing on the Southampton to Cowes route. Primarily a passenger ship she had a large partially-covered car deck. She, however, had her Voith-Schneider propellers replaced by twin screws. "Lymington"—still in service—is a dual-purpose vessel with well-equipped passenger accommodation as well as deck space for cars. She was built by Wm. Denny and Brothers, Ltd., at Dumbarton, and has the following dimensions: length, 132·2ft; breadth, 26·1ft; depth, 8·1ft; tonnage, 275 gross. She is driven by twelve-cylinder oil engines supplied by W. H. Allen Sons and Co., Ltd., of Bedford.

The vessel to be replaced, recently named "Freshwater II," is of an entirely different type being a paddle steamer (Fig. 3), having a tonnage of 264 gross and a length of 152·5ft. She has, since 1927, apart from war years, been engaged exclusively on carrying passengers, and is the last of a long line of paddle steamers plying between Lymington and Yarmouth. But the paddle as a means of propulsion asserted itself once more when a larger car ferry "Farringford" came into service in 1948. Because of the danger to the delicate propellers on "Lymington" at low water, so much so that on certain occasions sailings had to be cancelled, in the case of "Farringford" it was decided to adopt paddle wheels chain-driven from a diesel-electric unit. This vessel was fully described in these pages when she began her work.*

It was, however, found that with her deck houses and shallow draught she was not as easy to handle in strong winds when berthing at the slipways, and it was accordingly decided when a new vessel was under consideration that, on balance, the Voith-Schneider method of propulsion was best suited to requirements, which involved sailing down the narrow and tortuous Lymington river, and the limited space for manœuvring at both terminals.

The new "Freshwater" (Fig. 1) is intermediate in size between "Lymington" and "Farringford" having the following principal dimensions: length, overall, 164ft, at water line, 148ft; breadth, moulded, 30ft, breadth over sponsons, 42ft 6in; depth, moulded, 10ft; draught loaded, 6ft; tonnage, 362·71 gross, 146·35 net. She can carry twenty-eight cars, the number of passengers being governed by that of cars on board. When used exclusively for passengers 620 can be accommodated.

When this new ship is in regular service, she with the "Carisbrooke Castle"† on the Southampton–Cowes ferry, will add seventy-three to the total capacity for cars between the mainland and the Isle of Wight.

"Freshwater" was launched on June 24 at the yard of her builders, the Ailsa Shipbuilding Company, Ltd., Troon, and was recently delivered to her owners, the Southern Region of British Railways. As will be seen from the illustration she is double-ended and has hinged loading ramps at each end of the main deck, these ramps being in two sections, and when they are in stowed position the inboard sections hinge against the ends of the side bulwarks and so close the ends of the main deck. The centre portion of this deck is completely clear for its full length, and permits stowage of vehicles in three lines, but at times it may be necessary to rig portable cattle stalls at the

* THE ENGINEER, March 12, 1948, page 250.

† THE ENGINEER, June 5, 1959, page 886.

Fig. 2—M.V. "Lymington," 1938

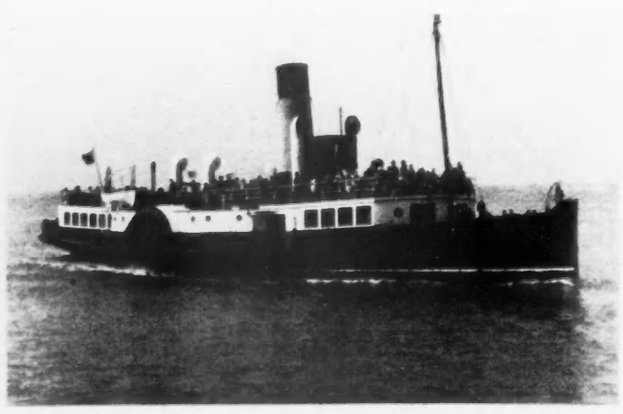


Fig. 3—P.S. "Freshwater" 1927

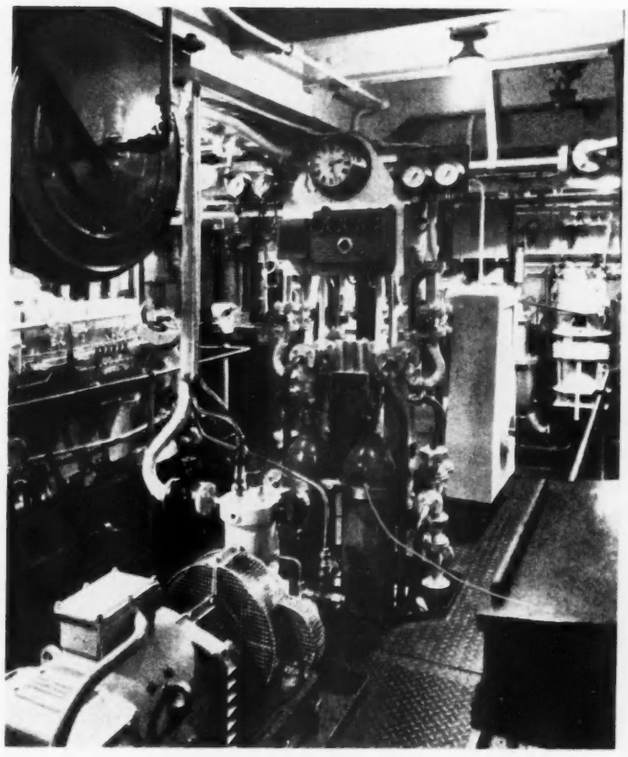


Fig. 4—The engine-room

forward and aft ends. Among the variety of loads to be carried might be mentioned the fairs and circuses which regularly visit the Island. The electric winches for operating the prows are housed below the main deck, while on the deck itself are the mooring and anchor capstans.

Passenger accommodation is found on both port and starboard sides of the main deck, comprising comfortable lounges, toilet provision for passengers and crew, mate's cabin, crew's galley and enclosed spaces for the stowage of baggage, mails, &c. The seating in the lounges is of upholstered tubular steel type, and the flooring is of marble pattern Nairn sheet lino. A lounge and bar/buffet are arranged on the lower deck, the seating being of upholstered settee type. The bar serving the bar/buffet is equipped with an electrically-heated tea and coffee set, stainless steel sink unit with a Sisson's " Whirl-A-Waste " refuse disposal unit, a cooled bottle storage cabinet, ice-cream conservator and drinking water cooler, and electric hot plate. The galley is furnished with a Belling electric cooker, electric water boiler and sink unit. Cabins for the Master and the Chief Engineer are situated on the boat deck.

Propulsion is by means of two Voith-Schneider, size 14E cycloidal propellers, one at each end of the vessel, the arrangement being similar to that which has proved successful in the " Lymington," with the forward propeller on the port side and the aft propeller on the starboard side. This layout, coupled with bridge control, makes manœuvring simple, an important factor when negotiating the winding Lymington river. There are no rudders as steering is done by varying the direction of thrust from the propellers, which were built under licence by Brown Brothers, Ltd., of Edinburgh.

The main machinery consists of two unidirectional Crossley type E.G.N. 8/65 diesel engines, each of which drives its associated propeller through a clutch, and G.W.B. universal joints and cardan shafts running in Cooper split roller bearings. The clutches engage and disengage automatically at 300 engine revolutions per minute. The main engines, each of which develops 320 b.h.p. at 650 r.p.m., are fresh water cooled, the salt water supply to the Serck heat exchangers and the fresh water circulating being effected by engine-driven pump. The engines impart to the vessel a speed of 10½ knots. A Hamworthy standby fresh water circulating motor-driven pump is provided, while emergency salt water circulation can be carried by means of a supply from the two general service pumps. The three starting air receivers are charged by an electric motor-driven air compressor of 8 cubic feet per minute capacity, at a pressure of 350 lb per square inch, and a diesel engine-driven compressor of 6 cubic feet per minute capacity at the same pressure. Both compressors are of Hamworthy "Dister" type, and a Lister engine is used for driving the diesel engine set. Separate lines from the receivers supply air to the generators, whistle, and sea inlet weed clearing system. Lubrication of the main engines is carried out by engine-driven pumps, with a motor-driven pump provided for emergency duties. The oil coolers are of Serck manufacture circulated by the main engine circulating pumps. A De Laval fuel oil purifier is provided which is fitted with twin pumps, and an Alfa Laval thermostatically controlled electric heater is on the suction side. All main and auxiliary machinery is lubricated by oils and greases supplied by Shell-Mex, Ltd.

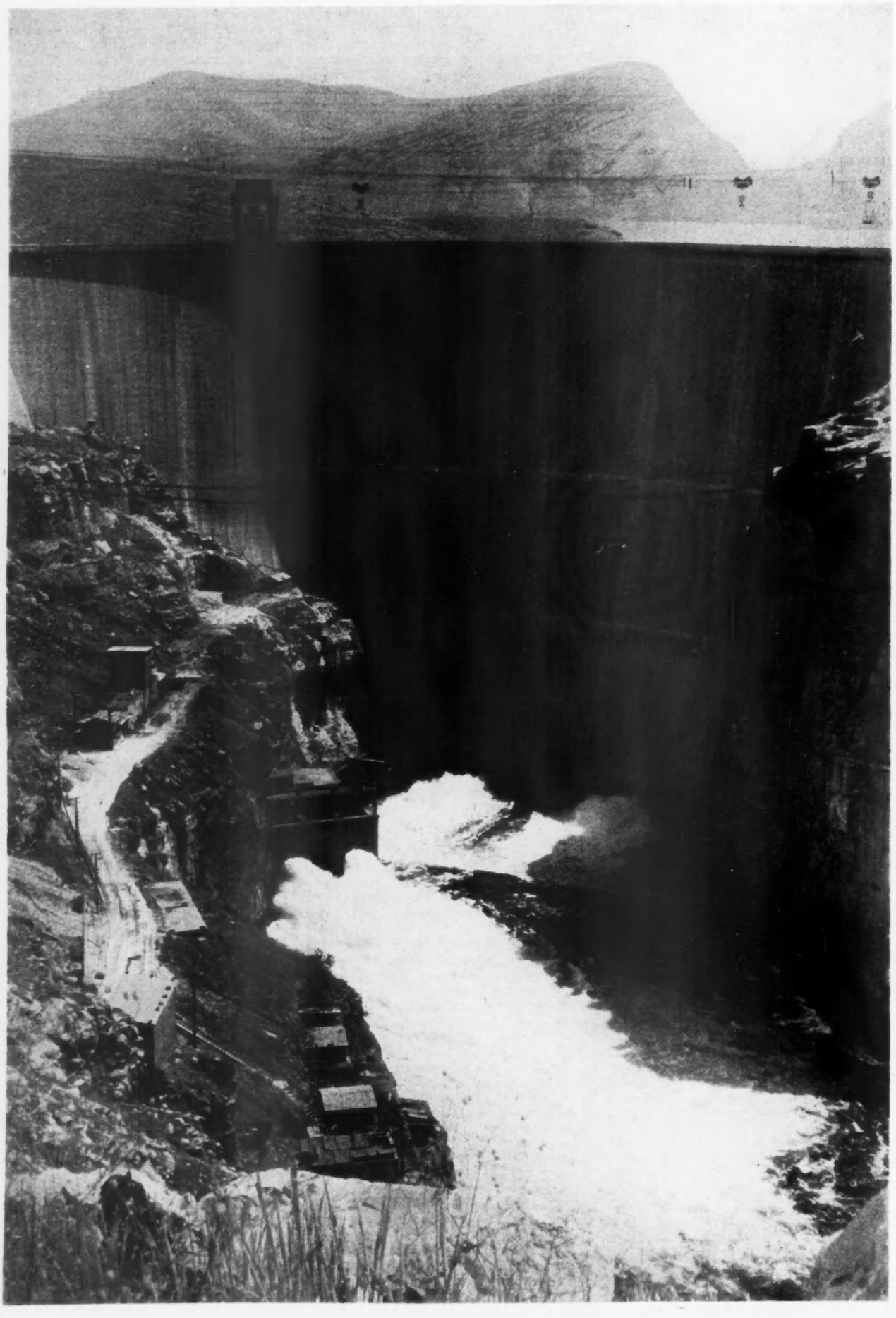
Electric current at 225V d.c. for lighting, power and electrically-driven auxiliaries is provided by two 60kW Mawdsley generators driven by Crossley type B.W.G./11 diesel engines running at 1100 r.p.m. The two general service pumps are of Hamworthy V.B. centrifugal type, motor driven. In addition to standby salt water circulating duties for main and generator engines, they carry out bilge, wash deck and fire duties, while an emergency connection to the sanitary water supply line is also provided, this supply being normally provided by a " Mono " M.60 type motor-driven pump, while a similar pump is fitted for domestic fresh water supply to the gravity tank on the bridge desk. Among other auxiliary plant may be mentioned an oily water separator, an oily bilge water pump, an oil-fired " Crane " boiler for domestic hot water supply, a Pulsometer pump to assist circulation in the hot water system, hot water radiators being provided in the engine-room (Fig. 4). Electric heating is provided in the wheel house and officers' cabins.

The navigating bridge is situated amidships above the boat deck and extends for the full width of the vessel. The wheel house is of steel and contains a central control pedestal for the Voith-Schneider propellers, a display unit for the Decca radar (the scanner of which is mounted on a mast on top of the wheel house, this mast also carries the brackets for the signal lamps), a " Sestrel " compass, a Pye v.h.f. ship-to-shore communications set, a microphone for the Marconi sound reproduction equipment, speakers for which are fitted on deck and in passenger and crew spaces, push-button type engine-room telegraphs, the various navigation light switches and indicating panels, and the controls for the " Secomak " electric and the compressed air operated " Diaphone " whistles. " Berkshire " window wipers are fitted to the centre wheel house windows, the blades of which can be parked and the windows fully opened.

Two Viking marine fibreglass lifeboats are on the boat deck, for which the davits are of Welin-MacLachlan " Crescent " outward turning type. Further buoyant apparatus takes the form of deck seats along the outboard sides of the boat deck, which with a number of sparred garden type seats altogether provide permanent seating on deck for over 200 persons. In this connection it should be mentioned that although normally employed on car carrying with a limited number of passengers, at the height of the season she will have to do the same as the " Freshwater " she replaces, and only carry passengers and it is anticipated that she will then be able to carry out six round trips a day as compared with the three normally made by the old " Freshwater." The sort of covered accommodation provided for passengers is clearly shown in the illustration (Fig. 5).

Fig. 5—View of one of the side lounges

With her two funnels abreast, reminiscent of some of the early paddle steamers, though she cannot claim to be a graceful ship, one that cannot compare favourably in her looks with her friendly rival " Carisbrooke Castle," she is certainly well suited to the duties she has to perform and with her two sisters " Farringford " and " Lymington " should be able to provide adequate service to motorists and ordinary passengers alike.



Dokan Dam

A major arch dam, the design and construction of which are described, has been completed at Dokan, on a tributary of the River Tigris, in Iraq. The reservoir which it forms is the key to multi-purpose developments for irrigation, flood control and power generation. A fundamental advance in the analysis of arch dams, the construction of an enormous "curtain" of grouted rock, and a study of reservoir operation, based on a "rule curve," are amongst the more novel aspects of the scheme. The dam is shown on the opposite page.

THE Tigris and Euphrates valleys are associated in many minds with early civilisations, depending on irrigation for their existence. Existing irrigation schemes in the Tigris valley cover quite large areas, and some of the ancient canals are still to be found. However, with a national exchequer replenished by royalties from the oil companies, Iraq has undertaken an ambitious programme of public works in recent years, one aim of which is to increase very substantially the acreage of land under irrigation, and also to solve the problem of river flooding. British engineering firms have had an appreciable share in these schemes; for instance, the Wadi Tharthar flood protection scheme in the Tigris valley was completed about three years ago.* With the completion of the Dokan dam on the Lesser Zab river, a left bank tributary of the Tigris, a major storage reservoir has been created which will have a fundamental effect on the general problem of conservation for the Tigris catchment.

The dam is an arch structure, 380ft in height, with a gravity abutment flanking one end of the arch, and a stepped abutment at the other end. The principal data relating to it are listed in Table I; it is depicted in cross section, and the accompanying plan

TABLE I—*Dokan Dam and Reservoir*

Reservoir :	
Useful storage capacity of reservoir	5,500,000 acre feet
Surface area of reservoir	105 square miles
Mean annual flow of river at Dokan	7160 cusecs
Catchment area upstream of dam	4500 square miles
Dam :	
Maximum height of dam, lowest foundation to crest	382ft
Crest length	1150ft
Radius of upstream face	394ft
Included angle of arch	115 deg.
Concrete volume	497,000 cubic yards
Volume of excavation (including power station)	262,000 cubic yards

of the site gives a good idea of the various tunnels, penstocks and ancillary works essential to the project. The dam is built across the foot of a U-shaped bend in the Dokan gorge, and advantage was taken of this configuration in driving the diversion tunnel and in constructing the gated spillway, as the plan clearly shows. However, the leakage paths from the reservoir were correspondingly short in this region.

The permanent works include the following features :—A system of grouting tunnels on both banks; five penstocks for a future power station embedded in the dam; an irrigation intake with two culverts leading to disperser valves downstream of the dam; a gated spillway for flood control, with its own tunnel leading back into the Lesser Zab; and a bellmouth spillway, which utilises part of the diversion tunnel.

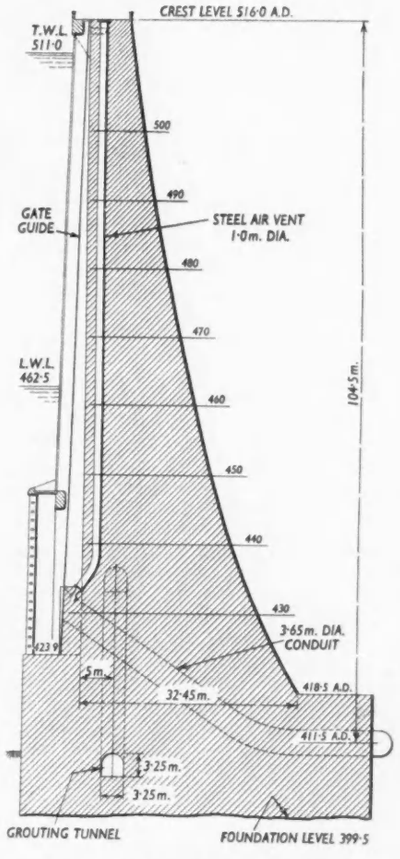
Constructional features included a thin-arch concrete cofferdam upstream of the dam, and the diversion tunnel already mentioned; cableways for the main concreting works; a quarry with crushers just to the left of the aggregate stock piles shown on the plan, and the usual aggregate and cement plant to serve two concreting stations, one for the dam and one for the tunnelling and spillway works.

* See THE ENGINEER, April 6, 1956.

The consulting engineers for the project are Messrs. Binnie, Deacon and Gourley. The main contractor is a group of French firms, of which Société Dumez and Entreprises Ballot are the principal partners, operating under the name Dumez-Ballot. The extensive sub-contract for grouting was carried out by the Cementation Company, Ltd., in association with Sondages, Injections, Forages, of Paris. The estimated cost of the dam is £11,300,000 plus £2,700,000 for the grouting.

THE "MATHEMATICIAN'S DAM"

The stress analysis of Dokan dam involved a research which is a classic in its field, and which utilised a method which is theoretically



Typical cross section through Dokan dam

more sound and far less dependent on arbitrary assumptions than other methods, such as the trial load method, which have been developed for the analysis of arch dams. The Dokan analysis was done by the process known as "relaxation." No three-dimensional problem of equal complexity had been undertaken at that time, however, and so the research also involved approximate analysis in two dimensions of simplified dam shapes, tests with rubber models, and the correlation of these two methods with the more exact three-dimensional analysis. This work was done at Imperial College, and the results published in the *Journal of the Institution of Civil Engineers* for May, 1956.†

Briefly, the method consisted of formulating elastic equations for the dam in terms of displacements, solving these equations by relaxation, and then deducing the stress components directly from the displacements. Calculations were made of stresses due to gravity loads, water pressure, and changes in temperature. The qualifying assumptions of the analysis required ideal elastic behaviour of the material of the dam and its abutments, and certain constructional precautions, viz. thorough keying between the dam and its foundations and grouting to ensure monolithic arch action under water load. The relaxation analysis has, in this case, actually computed stresses in the interior of the dam, and not merely interpolated them assuming linear stress distribution across the section.

Results under various loading conditions are, of course, to be found in detail in the reference just given. It may be of interest to mention, however, that the maximum direct stress, computed when the temperature of the dam is the same as the grouting temperature, due to gravity and water loads, is given as 480 lb per square inch. It occurs on the centre section of the water face, at a level of 479m, and is a hoop compression. Under these conditions vertical compression reaches a maximum of 340 lb per square inch at level 466m on the water face and vertical tension on the air face 120 lb per square inch at 479m; there is no hoop tension nor vertical tension on the water face. A temperature rise lowers the maximum hoop compression, but increases the vertical compression. For maximum temperature fall the maximum hoop compression increases to 515 lb per square inch, which is the highest stress found in the analysis.

GROUTING

The geology of the dam site was broadly favourable from the point of view of structural foundations and abutments, but necessitated a very extensive programme, first of investigation and then of grouting, to ensure that the reservoir would not leak. In fact, the grouting programme is considered to be probably the largest of its kind which has ever been undertaken.

Dokan gorge cuts through an anticlinal ridge of cretaceous rocks which are massive in character and mechanically strong. The bed rock is dolomite, which is overlain by limestone, shale and marl. The solution effects characteristic of limestone and dolomite were the principal reason for the grouting programme. Several systems of caverns were found, particularly on the left bank, but they seldom extended far into the rock mass, since drainage tended to follow the dip (the strike direction is generally north-west–south-east) of the strata to the ground surface.

The cut-off curtain of grouted rock extends into the high ground on each side of the dam. Most of the drilling and grouting was done from the two tunnels shown on the plan but drilling was also done from the surface beyond the ends of the tunnels. The grouting tunnels were generally unlined but with a concrete invert; their cross section—an 11ft 6in by 8ft horseshoe—was large enough to work with a wagon drill. The tunnels were lined, however, where they crossed major fissures, so that the tunnels

† "The Experimental and Mathematical Analysis of Arch Dams with Special Reference to Dokan," by Professor D. N. da G. Allen L. Chitty, Professor A. J. S. Pippard and R. T. Severn; and "The Determination of the Stresses in an Arch Dam from a Rubber Model," by L. Chitty and Professor A. J. S. Pippard.

themselves did not form leakage paths.

The curtain was formed by grouting from a single line of holes. Depths up to 100m were drilled by wagon drills; rotary drills with tungsten-carbide or diamond bits were used for greater depths, or for upwardly-inclined holes. As the work proceeded, knowledge of the nature of the ground and the efficacy of the treatment was built up and secondary and sometimes tertiary holes were drilled between the primary ones, and further grouting carried out.

A thin mix with a water/cement ratio of 8 was used at the start of grouting and this was thickened if the design pressure was not soon approached, and thinned again when the pressure built up. The maximum pressures used for grouting were 285 lb per square inch in limestone and 570 lb per square inch in the dolomite. In badly fissured regions the maximum pressure was 285 lb per square inch. When pressures did not increase satisfactorily a fine sand was mixed with the grout.

The left bank curtain extends for almost 4500ft from the dam and the right bank one for 3400ft. In addition, there is the curtain below the dam, which was largely grouted at the stage of foundation construction and which did not consume large quantities of grout except where a group of springs was intercepted and special treatment was needed. Further grouting work was also undertaken to strengthen the left abutment and provide complete assurance that the rock would take the thrust of the dam arch: 750,000 cubic yards of rock were treated in this region, up to a pressure of 142 lb per square inch. The magnitude of the grouting works can be judged from the figures in Table II.

TABLE II—*Principal Data for Grouting Programme*

The grout curtain :	
Area of grout curtain	4,528,000 square feet
Total length of grout curtain	8,325ft
Total length of drill holes	601,000ft
Materials consumed in grout mixtures :	
Cement	45,600 tonnes
Sand	32,200 tonnes
Water	More than 100,000 tonnes
Unit rates of grout consumption (dry materials) :	
Per foot drilled	283 lb
Per square foot of curtain	35·5 lb
Strengthening left bank abutment :	
Volume of rock treated	750,000 cubic yards
Total length of drill holes	95,000ft
Materials consumed :	
Cement	1,707 tonnes
Sand	471 tonnes
Unit rate of consumption (dry materials)	0·25 lb per cubic foot

After treatment, over sixty test holes were drilled to assess the efficacy of the grout curtain. In general terms, it was concluded that a high standard of watertightness had been achieved.

Concreting the Dam

Concrete for the dam was weigh-batched and mixed at a central station which had four 1 cubic metre mixers. It was then taken by dumpers and transferred to 2 cubic metre cableway skips. There were four 6-tonne cableways which placed all the concrete for the dam except for the left abutment, where a derrick placed concrete from the subsidiary batching plant shown on the plan. Lifts of 5ft were generally used and concreting was carried on day and night during the winter, but not in the day during the summer. During the main concreting programme a rate of 28,000 cubic yards per month was maintained for fourteen months. The following data for the concrete are arranged according to the "brief description" recommended by the International Sub-committee on Concrete of the Congress on Large Dams.

(*a*) Cement content: 337 lb per cubic yard. On water face for a thickness of 13ft and for 6·6ft depth over the foundations, 421 lb per cubic yard.

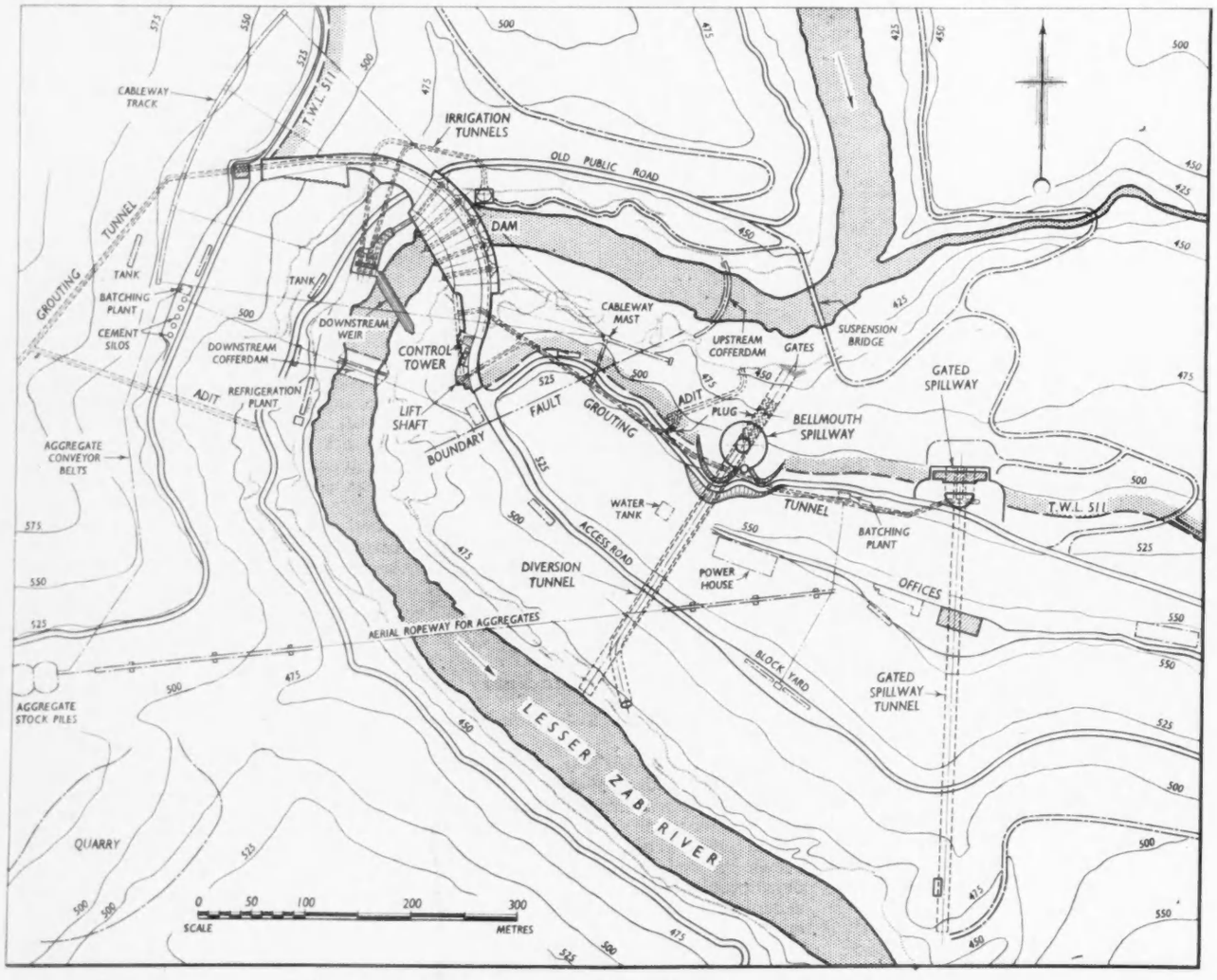
(*b*) Effective water/cement ratio: 0·7–0·9.

(*c*) Type of cement: low heat Portland (B.S.S. 1370 : 1947) from either Baghdad or Sarchinar cement works.

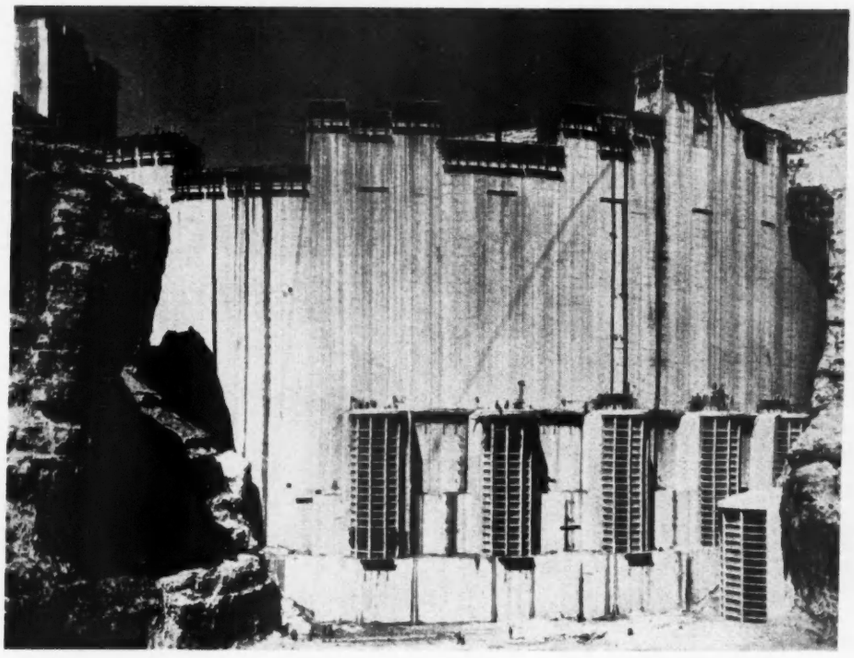
(*d*) Petrology of aggregate: crushed limestone from a quarry on the right bank, including the sand. The gradings produced were: 6in to 3in; 3in to 2in; 2in to 1in; 1in to $\frac{3}{8}$in; $\frac{3}{8}$in to $\frac{3}{16}$in for coarse aggregate. Continuous grading was in fact achieved by omitting the second largest and the smallest gradings listed, owing to undersizes in each grade. Sand was graded hydraulically to Class A, B.S.S. 882, except that only 5 per cent passed the No. 100 sieve.

(*e*) Method of compaction: by heavy-duty immersion vibrators, each of 4 h.p., and operating at 10,000 r.p.m. Each 1·5m lift was placed in at least two layers.

(*f*) An air-entraining agent—generally "Darex"—was used.



The dam site, showing the permanent works, constructional works and plant installation



Upstream face of dam during construction. The trash racks for the five turbines' intakes and the irrigation intake are of precast concrete. There is no cleaning mechanism, since the uplands are unwooded, and the trash racks are intended only to prevent accidents to the turbines

(*g*) Estimated air content of finished concrete 2 per cent by volume.

The hearting concrete was, in fact, about a 10 : 1 mix. Twenty-eight-day cube strengths (the large aggregate was sieved out to make the test cubes) of 3937 lb and 4482 lb per square inch were obtained respectively from concrete made with cement from the two works, the corresponding figures for standard deviation being 661 and 682.

Cooling of the concrete was effected by circulating water from a refrigerator plant in pipes laid as shown in one of the illustrations. Apart from the usual reason of controlling the temperature rise caused by the heat of hydration of the cement, two other factors were operative. The downstream face of the dam is exposed to the sun and it was estimated that a temperature difference of 30 deg. Fah. would exist when the reservoir was full, between the two faces. It was therefore considered that the final temperature pattern in parts of the dam where the concrete was restrained (e.g. by foundation rock or penstocks) should be established in three months while the concrete was still plastic. In other areas, the temperature was lowered to a few degrees below the anticipated ultimate temperature prior to grouting the construction joints. Then subsequent increase of temperature would induce compression. This precaution was, it will be recalled, one of the assumptions inherent in the stress analysis of the dam.

Grouting of the construction joints was done simultaneously at any one level, to avoid unbalanced horizontal thrust. The grouting pressure was 28 lb per square inch.

Other Constructional Works

Some of the leading features of the various works ancillary to the dam itself are now given.

Penstocks.—One of the illustrations shows construction at the stage when the penstocks are being embedded in the concrete of the dam. There are five of them, each 12ft in diameter, and of welded steel. The circular bracing to be seen hooped around each penstock serves to relieve tensile stresses in the neighbouring concrete, and obviates the need for internal bracing at the constructional stage.

Four of the penstocks are closed by domed closing-pieces on the downstream side. Each of them has capacity to supply a 40MW turbine when the power station is built. There are also two culverts which discharge irrigation water through sleeve-valve discharge regulators into the river on the downstream side of the dam. The fifth penstock has in fact been extended and aligned with these two outlets, as a third irrigation supply.

All seven of these openings have a gate well close to the upstream face of the dam, and a single emergency gate can be carried on a rail-mounted portal crane of 150 tons capacity to any one of them. In addition the irrigation outlets are each controlled by a butterfly valve.

Flood Control Works.—Design of the two spillways was governed by the method of reservoir operation outlined in the next section of this article. Referring again to the plan it will be seen that there are two flood spillways, one of which is controlled by three vertical-lift gates and thus governs the top water level of the reservoir. The second is a bellmouth spillway, which discharges into the diversion tunnel, just below the concrete plug which was built in this tunnel on completion of the dam. The diameter of the tunnel was then reduced and a new outlet giving satisfactory hydraulic characteristics was built. This bellmouth spillway is an exceptionally large one. Its diameter is 140ft at the weir and 41ft at the shaft, and its discharge capacity is 65,600 cusecs at 13ft head. It was built with precast concrete blocks.

The combined discharge capacity of both spillways for a reservoir level of 516m is 151,000 cusecs.

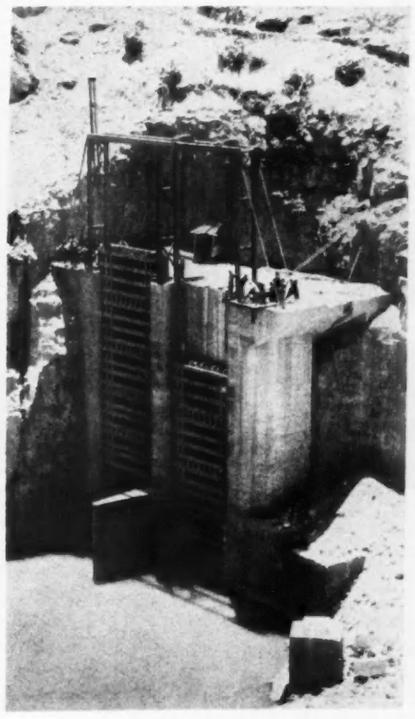
Operation of Reservoir

An interesting aspect of the design of the Dokan scheme has been an intensive study of the operation of the reservoir, based on irrigation demands and the flows in the Lesser Zab over a ten-year period. The demand for water from storage for irrigation occurs during the second half of the year. The flow of the river is quite extreme in its irregularity, but nevertheless the Dokan reservoir is large enough to maintain a supply of 4,000,000 acre feet per annum over a ten-year dry period, combined with flood protection, but with rather limited firm power generation. If one assumes an average depth of 4ft per annum for irrigation, the reservoir is able to irrigate about 1,000,000 acres.

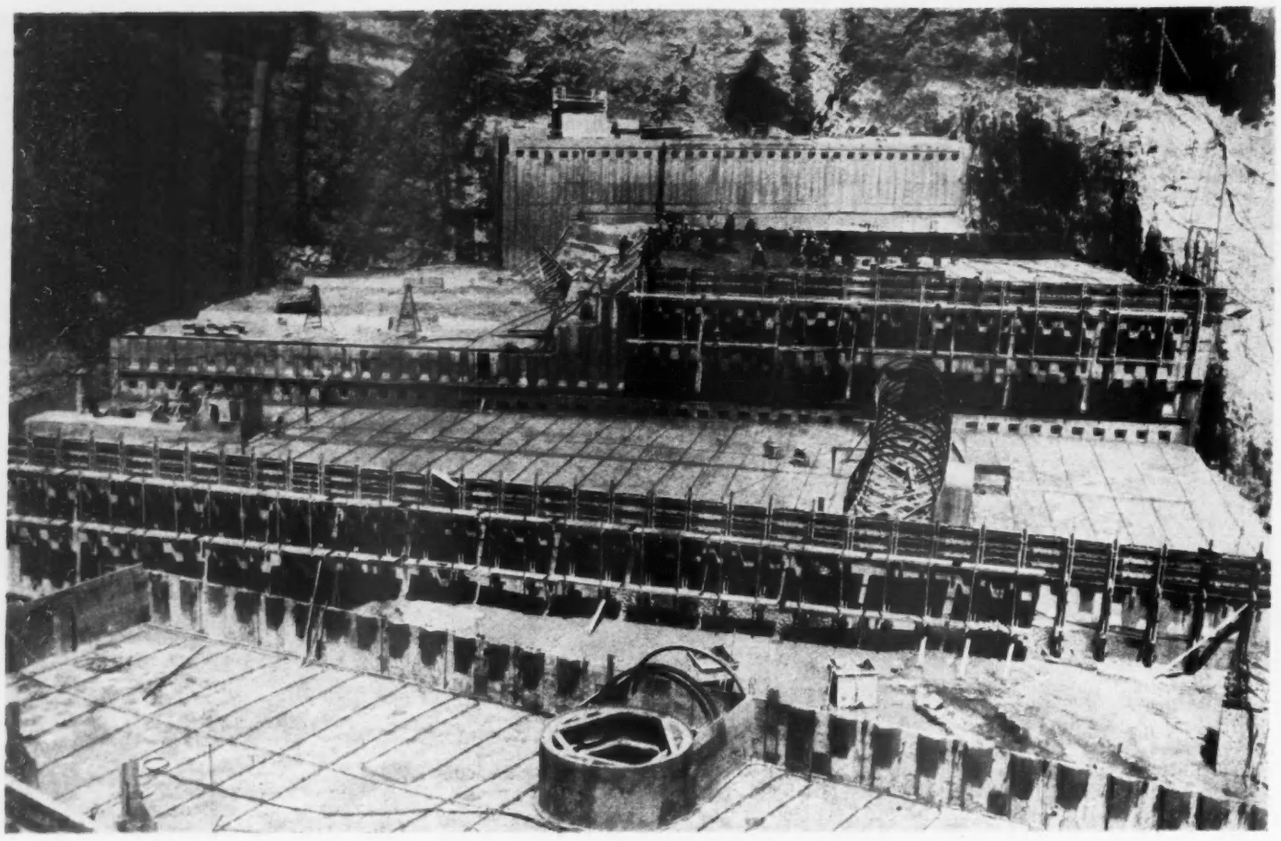
Recent investigations have shown that some of the best agricultural land in Iraq is in the region of Kirkuk. This upland area is well situated to receive irrigation supplies from a canalisation system from the Lesser Zab. The system might well include upland areas lying between Kirkuk and the Diyala river, and augmentation of water to other areas already under irrigation in the Tigris catchment.

The basic principle of the operating study has been the use of a "Reservoir operation rule curve" governing flood protection. The rule curve is shown in the diagram herewith, from which it will be seen that the reservoir level is drawn down to a maximum of 505m, that is 6m below top water level, in the winter period, with specified intermediate maximum levels over autumn and spring transition periods as shown, such that top water level is permissible only during June, July and August. Use of this method is possible because of the invariable succession of dry summers and rainy winters. From the beginning of March, the probability of a major flood diminishes, and hence a gradual decrease of flood storage is permissible. Some of the principal river flow and storage figures will illustrate the position, and so are given in Table III.

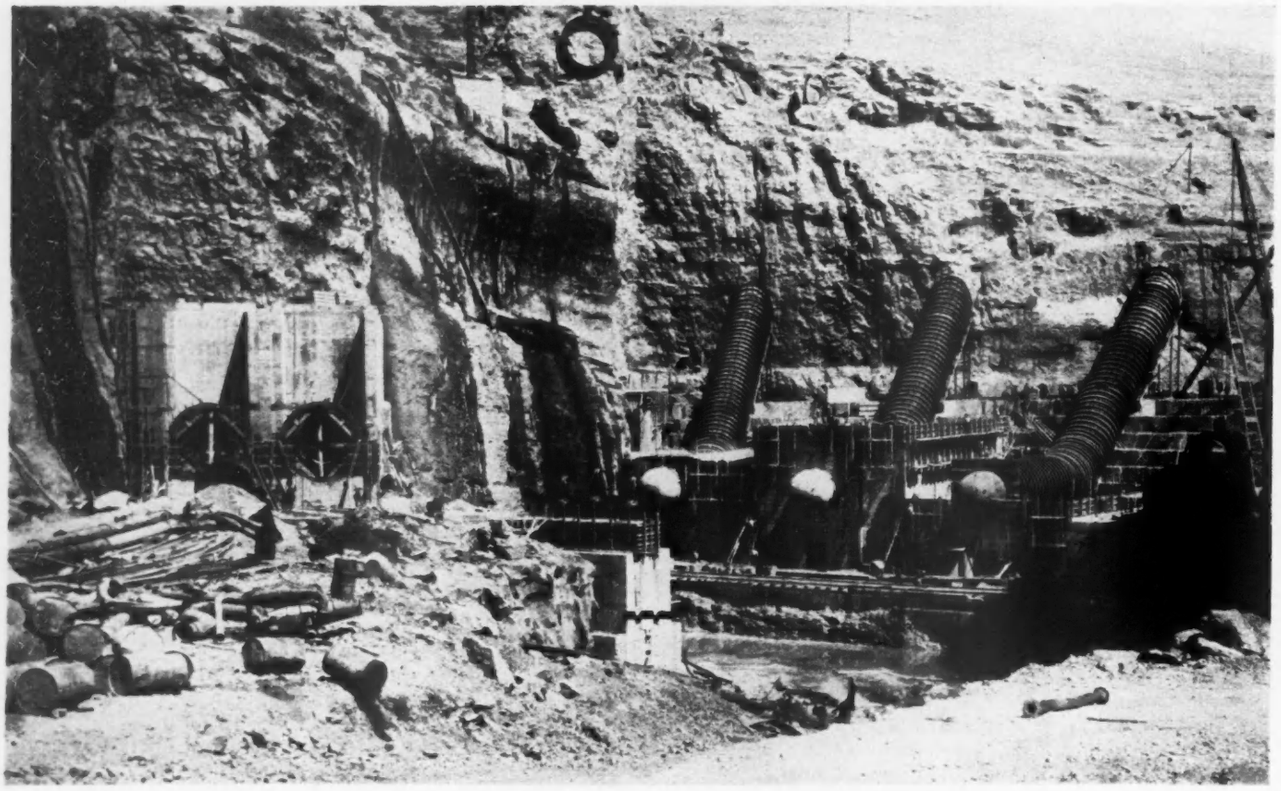
A practical result of the reservoir study has been that adherence to the rule curve does not significantly reduce the value of the reservoir as a source of irrigation water. Another result has been that the total spillway capacity could be reduced to 4300 cumecs, whereas the "design flood" is

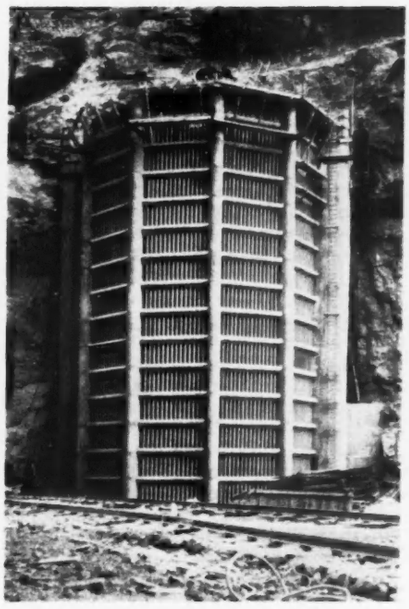


Entrance of diversion tunnel showing bulkhead gates



Early stages in concreting the dam are illustrated on this page. The upper view shows typical blocks ready for concreting, with shuttering and cooling coils in position. Formwork for an inspection gallery is being prepared, and in the background concrete is being placed.
In the lower view the penstocks are shown partly erected. The hoop-shaped steel bracing surrounding each penstock serves to stiffen the penstock while the concrete around it is placed and sets, and also as reinforcement in the completed structure. On the left is the partly constructed outlet block of the irrigation supply tunnel, and in the centre foreground the downstream weir is under construction





Irrigation supply tunnel intake with trash rack nearly completed

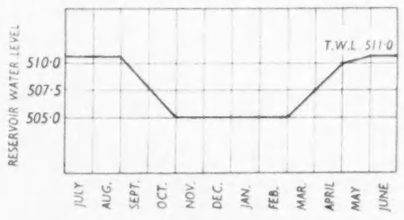
13,300 cumecs. We also illustrate the flood hydrograph for the "design flood" routed through the reservoir.

Subsequently, the Hydrological Survey of Iraq estimated that the "probable maximum flood" had a peak discharge of 18,000 cumecs, but as the volume of this estimated flood was approximately the same as the volume of the "design flood," no increase in

TABLE III—*Hydrological Data for Dokan Reservoir*

Discharge of the River Zab at Dokan :	
Long-term average	203 cumecs
Maximum recorded flood	3,660 cumecs
Minimum recorded summer flow	26 cumecs
Normal range of flow variation	2,000 to 45 cumecs
Design flood	13,300 cumecs
Useful storage capacity of reservoir	$6{\cdot}8 \times 10^9$ cubic metres
Mean annual discharge	$6{\cdot}4 \times 10^9$ cubic metres
Flood storage available above 505m level (i.e. up to end of February)	$1{\cdot}5 \times 10^9$ cubic metres
Flood storage on May 1	$0{\cdot}3 \times 10^9$ cubic metres
Estimated annual yield of reservoir for irrigation	$5{\cdot}15 \times 10^9$ cubic metres

the total spillway capacity was needed. It will be evident that in the early years of the reservoir's life there will be ample surplus of water for hydro-electric power generation. Paradoxically enough, the centres of power consumption are situated nearer to the oil fields whose waste gases

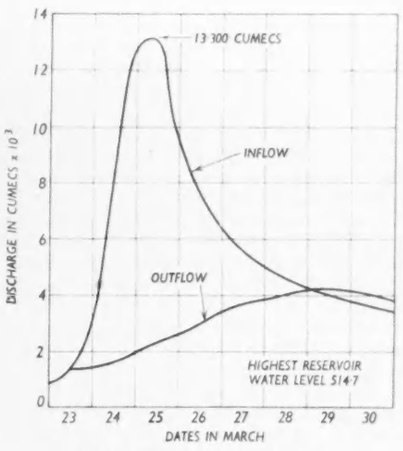


Reservoir operation rule curve

offer cheaper power at the moment even than the construction of the Dokan power station. Hence the penstocks have been "blanked off," as already described, and work on the power station is not yet in prospect though an installation of five 40MW sets is provided for.

The problems of reservoir operation have been described briefly, and for a fuller explanation of this absorbing subject we would refer the reader to a paper given at

NOTE: 1 cumec = 35·3 cusecs.



Hydrograph of "design flood"

the 1957 sectional meeting at Belgrade of the World Power Conference.‡ Sufficient has been written here, however, to indicate the critical importance of the Dokan reservoir to the success of the widespread irrigation schemes below it, and of its equally important functions of flood control and year-to-year storage and its potentiality for power generation. Only one other fact need be mentioned affecting reservoir operation, viz. that of silting. It has been estimated that the silt load of the Lesser Zab at the reservoir is in the region of 1,000,000 cubic metres per year. This figure is equivalent to about one hundredth of 1 per cent of the total storage at the start of the reservoir's life, so the rate of loss of capacity is very small.

From the foregoing description, it will have been evident that the design and construction of the Dokan dam have brought with them unusually interesting engineering problems, and correspondingly elegant design solutions. Thus a great deal of ground has had to be covered in these columns, and some aspects of the work have scarcely been mentioned. However, a scheme of such magnitude attracts numerous papers, and apart from those already referred to, the constructional aspects of the scheme will be expounded upon in papers to be presented this month at the Institution of Civil Engineers, at the November 17 meeting, and entitled : "The Dokan Project." 1. "The Dam," by G. M. Binnie, J. G. Campbell, R. H. Edginton, C. A. Fogden, and N. H. Gimson (paper No. 6389). 2. "The Flood Disposal Works and the Grouted Cut-off Curtain," by G. M. Binnie, J. G. Campbell, N. H. Gimson, C. A. Gillott and P. F. F. Lancaster-Jones (paper No. 6390).

‡ Paper B1 : "The Potential Benefits for Irrigation, Flood Protection, and Power of the Dokan Dam Scheme in Iraq," by G. M. Binnie. This paper is superseded to some extent by the proposal mentioned above to irrigate the Kirkuk area.

Application of Irradiation in Industry

The application of irradiation in industry was discussed in a paper by M. C. Crowley-Milling at a meeting of the Institution of Electrical Engineers in London on November 5. The author began by showing that only γ-rays and high speed electrons need be considered for industrial irradiation. He went on to discuss possible applications, the methods of producing such radiation, and the problems of introducing them to industry. He ended by considering the economics of irradiation with special reference to electron systems. Extracts from the paper are reproduced here.*

OVER the last ten years, many workers have been investigating the effects of ionising radiation on various materials, and it has been shown that irradiation can be a commercially useful process. Up to date, it has only been used in comparatively few instances, but it is anticipated that the number of installations will increase very greatly in the next ten years. The aim of the paper is to provide a brief engineering approach to the special problems of applying irradiation in industry.

TYPES OF RADIATION

There are two types of ionising radiation, namely electromagnetic waves and streams of particles. The electromagnetic waves of interest are those of very short wavelength, known as X-rays or γ-rays. It has been usual to call such radiation X-rays when produced by the slowing of high-speed particles in a target material, and γ-rays when produced by radioactive disintegration, but they are physically identical.

Ionisation can be caused directly by charged particles, such as electrons, and indirectly by neutral particles, i.e. neutrons. High-energy charged particles heavier than electrons are expensive to produce and have a much smaller range than electrons of the same energy, and are not likely to be applied commercially. Irradiation by neutrons can cause the production of radioactive isotopes of some materials, and so is not to be recommended.

This leaves high-energy electrons as the only particles suitable for industrial irradiation. Streams of electrons are sometimes known as cathode rays, and, if produced by radioactive disintegration, they are also known as β-rays.

Dose Units and Activity.—In nearly all cases, the ionisation produced, and thus the desired effect is proportional to the power absorbed in the material. Several units have been used in the past to describe the radiation dose, but, at the International Radiological Conference held in Copenhagen in 1953, it was agreed that the unit of absorbed dose should be the rad. A substance is said to have received a dose of 1 rad when it has absorbed 100 ergs per gramme of material, from any kind of radiation. For engineering applications its multiple, the megarad, is more useful. This is equivalent to the absorption of 10 joules per gramme or 1·26 watt-hours per lb. Thus about 800 lb per hour of material can be given a dose of 1 megarad for each kilowatt of power fully utilised.

APPLICATIONS

The main applications for irradiation can be divided into two classes : one in which it is desired to change the molecular composition of a material to alter its properties, and the other in which it is desired to affect some impurity or unwanted part without appreciable effect on the main body of the material.

The first class includes polymerisation and

* Metropolitan-Vickers Electrical Company, Ltd.

cross-linking of plastics, including the formation of copolymers, vulcanisation of rubbers, halogenisation of aromatic compounds and other chemical effects.

The second class includes sterilisation of pharmaceuticals, preservation of food, disinfestation, and prevention of sprouting of potatoes and onions.

Polymerisation and Cross-Linking of Plastics.—Large doses of radiation can cause polymerisation and cross-linking in plastics.[1, 2] Doses needed are of the order of 5–100 megarads.

Polythene, when fully cross-linked, no longer melts, and it remains as a rubber-like solid up to a temperature of about 350 deg. Cent., and resists organic solvents. Although the development of high-temperature polythenes has made irradiation unnecessary in a number of applications, it is still needed for temperatures over 125 deg. Cent. or for use in oils. The main applications of irradiated polythene so far are for small parts, such as valve holders, containing inserts which have to withstand the heat of soldering, and for cables and tapes. Polythene-insulated wire and wrapping tapes are available commercially in this country and the United States.[3, 4] Graft polymerisation, in which a monomer is polymerised in contact with a different polymer, forming an intimate bond, is also possible by means of irradiation. Possible applications are the bonding of a layer of styrene to polytetrafluorethylene to improve the adhesive properties.

Some other plastics, such as p.v.c., degrade when subjected to large doses of radiation.

Vulcanisation of Rubbers.—Vulcanisation is a form of polymerisation, and both natural and synthetic rubbers can be vulcanised by irradiation.[5] The chemical agents needed for heat vulcanisation are not required and a better product results. It is reported that motor tyres vulcanised by irradiation have 10 per cent greater abrasion resistance than ordinary tyres.[6] Silicone rubbers vulcanised easily and rapidly by irradiation.[7]

Chemical Reactions.—Many chemical reactions can be initiated by irradiation. For example, when aromatic compounds are irradiated in the presence of halogens, addition products are formed. One process, the formation of γ-hexachlorocyclohexane, a powerful insecticide, by the irradiation of a mixture of benzene and chlorine, has been shown to be commercially attractive.[8] If hydrocarbons are irradiated in the presence of sulphur dioxide and oxygen, sulphonic acids are produced, which are the bases for certain detergents.[9] Other chemical processes, such as the cracking of hydrocarbons to produce improved fuels, are under investigation.[10]

Sterilisation of Pharmaceuticals.—Considerable experimental evidence exists that doses of the order of 2–5 megarads will reduce the probability of finding a living organism by a factor[11, 12] of at least 10^{10}. Unless the initial contamination is excessive, such a reduction is acceptable as giving complete sterility, and electron sterilisation has been applied commercially to eye-drops and surgical sutures.[13] Further applications are likely to follow slowly, as there is an understandable desire to make certain that there are no harmful effects. Some changes may be necessary to the relevant Food and Drug Acts before radiation sterilisation can be applied widely.

The dose needed for sterilisation causes only a small rise in temperature, and thus heat-sensitive drugs can be sterilised, as can surgical instruments, dressings, blankets, &c., which would be damaged by heat.

Preservation of Food.—Probably more money is being spent on investigations into the possibility of preserving food by irradiation than on any other application, mainly owing to the programme of the Quartermasters' Division of the United States Army involving the expenditure of several million dollars.[14]

As with pharmaceuticals, foods can be effectively sterilised with doses of the order of 2–5 megarads, but such doses cause unacceptable changes of taste in most foods. Those least affected, namely, pork, poultry, vegetables and fruit, have been irradiated and fed to animals and human beings to determine any ill effects. So far none have been reported.[15] Lower doses, of the order of 50,000–500,000 rads, do not cause complete sterilisation, but improve the keeping qualities of many foods, and may allow storage under chilled conditions, rather than deep freezing. Irradiation with low-energy electrons, which do not penetrate deeply, may be helpful in reducing the growth of moulds on fruit, without appreciable effect on the taste.

Potatoes and onions can be stored without sprouting if previously given a dose of about 10,000–20,000 rads.[16]

Disinfestation.—Doses of the order of 50,000 rads are lethal for most insect pests, and any not killed by this dose do not reproduce. Most insect eggs are made infertile by even lower doses.[17] Food parasites can also be killed in this manner, such as trichina in pork, which requires doses of the order of 30,000 rads.[18]

Production of Radiation By Electron Accelerators

Direct Accelerators.—Direct accelerators are the simplest type of electron accelerators and take the form of a high-voltage supply which can be alternating, half-wave rectified, or smoothed direct current, connected between the anode and cathode of an evacuated tube. Shaping of the electrodes, or additional focusing electrodes, allow the accelerated electrons to be formed into a narrow beam which passes through a hole in the anode, which is usually at earth potential. It is then necessary to bring the electron beam through the vacuum envelope. At low energies, under 500 keV, any practical vacuum window will absorb a high proportion of the electron power. This causes difficulties with window cooling, as well as reducing the efficiency. The difficulty has been overcome in one equipment by focusing the beam to a very small diameter and passing it through a narrow tube between the vacuum system and the outside atmosphere.[19] This tube has a labyrinth system fitted with very-high-speed vacuum pumps, so that a low pressure can be maintained in the vacuum chamber despite the direct connection to the atmosphere.

At higher energies thin windows can be used. These reduce the effective energy by about 150kV. The loss of efficiency is still noticeable, and thus special attention to window cooling is needed at high powers. For these higher-energy machines, the power supply usually takes the form of a resonant transformer or electrostatic generator.

The resonant-transformer accelerator, developed mainly in the United States,[20] uses an air-cored transformer excited at its resonant frequency, which is usually some multiple of the mains supply frequency. The accelerator tube is mounted in the centre of the transformer. The transformer is contained in a steel tank filled with sulphur hexafluoride under pressure to prevent breakdown. An alternating voltage is applied to the accelerator tube, and current passes on alternate half-cycles. The resonant-transformer accelerators available commercially are given in Table I.

TABLE I—*Electron Accelerators Available*

Type	Maker	Electron energy	Mean power	Approximate price of accelerator	Approximate cost per kW*
		MeV	kW	Dollars	£
Resonant transformer	A	1	4·5	69,000	5,400[21]
		2	10	120,000	4,300[21]
		3·5			
Van de Graaff	B	1	0·25	40,000	57,000
		1·5	2·5	50,000	7,100
		2	0·5	73,000	52,000
		3	3	130,000	15,500
Linear accelerator	B	6·5	4	194,000	17,400
		9·5	4	224,000	20,000
	C	6	4	145,000	13,000[21]
	D	6	5	—	—
		10	5	—	—
		20	2·5	—	—
	E	4	0·8	£30,000	£37,500
	F	4	1	£30,000†	£30,000
		5	5	£50,000†	£10,000
		10	10	£90,000†	£9,000

* Conversion at 2.80 dollars = £1 (neglecting import duty, taxes, &c.).
† The exact figure depends on equipment provided.
The figures are supplied by manufacturers unless references are given.

The electrostatic generator most used is that due to Van de Graaff.[19] A moving belt is used to transfer charge from a low-potential electrode to a high-potential electrode. An electron tube, similar to that used in the resonant transformer, is connected between the high-potential electrode and earth. The steel container allows the whole equipment to be enclosed in a mixture of nitrogen and carbon dioxide at several atmospheres pressure to prevent breakdown. Van de Graaff generators have been constructed to produce voltages of the order of 8 MeV, but the limit for reliable commercial operation seems to be about 3 MeV, and the models commercially available are given in Table II.

TABLE II—*Running Cost of Electron Accelerator*

Capital cost	£
5 MeV 5kW linear accelerator	50,000
Building and conveyor	20,000
Spares	4,000
	74,000

Hourly running costs	£ s. d.
Klystron replacement	15 0
Modulator valves	10 0
Other valves and components	5 0
Skilled maintenance (part time)	3 0
Miscellaneous	3 6
Electric power 42kW at 1d.	3 6
	2 0 0

Total costs (per hour)	40 hours per week £ s. d.	Continuous service £ s. d.
Depreciation on capital 10-year basis	3 17 0	19 3
Interest on capital, 5 per cent on £37,000	18 6	4 6
Running costs	2 0 0	2 0 0
Total	6 15 6	3 3 9
or	1 7 0	12 9
	per kilowatt-hour	per kilowatt-hour
Equivalent to about	0·4d. per megarad-lb	0·2d. per megarad-lb

Indirect Accelerators.—For reliable production of electrons with energies higher than

about 3 MeV, indirect accelerators must be used, and these obtain the necessary acceleration without the use of very high potentials. The indirect accelerator which has made possible the provision of high powers at high electron energies is the microwave linear accelerator.[21] In one typical form, electrons are accelerated by the axial field due to an r.f. wave travelling down a special waveguide at the same velocity as the electrons. Early accelerators used magnetrons[22, 23] to supply the r.f. power needed, and were thereby limited to outputs of the order of 1kW mean power, but very-high-power klystrons have now been developed for this purpose,[24] removing the limit on power that can be produced by a single accelerator. There is no fundamental limit to the energy attainable by a linear accelerator, but, as mentioned above, a practical limit for irradiation purposes may be set by the production of radioactive isotopes in the material being irradiated. The highest-power linear accelerator yet constructed was built for neutron research[25] and was designed for a power output of 30kW at 25 MeV. This machine is made up of six sections, and a smaller number of sections would make a suitable irradiation source, such as 4 MeV, 5kW; 8 MeV, 10kW, &c. Variation in waveguide length and the number of klystrons makes it possible to produce a machine to fit almost any specification of energy and power likely to be required for irradiation. A number of linear accelerators are commercially available. Those known are listed in Table I.

γ-Rays for Irradiation

The main sources of γ-rays for irradiation are the radioactive isotopes produced by nuclear fission or neutron bombardment.

Fission Products.—When uranium 235 is split a large number of radioactive isotopes are produced, ranging from rhodium 106 with a half-life of thirty seconds, to cæsium 137 with a half-life of thirty years.

There are several ways of utilising the fission products.

(*a*) Direct irradiation in a nuclear reactor. The irradiation dose from neutrons would probably exceed the γ-ray dose, and there would be a great risk of induced activity in the material being irradiated.

(*b*) Circulating fuel. In a liquid-fuel reactor it would be possible to circulate the fuel, containing the fission products, through an irradiation chamber. Delayed neutrons may well be a serious problem, and the quantity of fuel required for the reactor would be increased considerably.

(*c*) Gaseous fission products from a liquid-fuel reactor. About one-third of the fission products are gaseous, and if the reactor uses liquid fuel, such as a solution of uranium salts in water, the gases can be removed and pumped to an irradiation cell. Most of the γ-rays radiated from the gaseous products are of low energy, below 0·5 MeV, and thus a large amount of the power would be absorbed in the double-walled container needed for safety.

(*d*) Fuel rods from reactor. The fuel rods of a solid-fuel reactor become "poisoned" with fission products after a while, and have to be removed for reprocessing. It is usual to store these under water for some months, to allow the activity to fall to a low level before reprocessing. Such rods have been used, on a small scale, to provide experimental irradiation facilities. Most of the activity is due to short-lived isotopes, and thus the fall of activity with time is very rapid at first when the activity is high. The average energy is low (about 0·8 MeV) and the self-absorption in the rods is high, so that the available power is small. Transport of the fuel rods may be a problem which may be realised when the proposal described in reference [26] is considered. Here an average of seventy-six fuel elements need replacing each week, and it is likely that each element would have to be transported separately in several tons of lead. The effective power of this facility is 4·9kW.

(*e*) Separated fission products. Potentially the most useful of the separated fission products is cæsium 137. In this country it is separated as the sulphate salt with an activity of about 17 curies per gramme or about 30W per pound. Figures are not available, but it is thought that the annual production is not more than a few thousand curies. It has been estimated that, as a result of the power-reactor programme, the annual production[27] of cæsium 137 should be 10^7 curies by 1965. If all this could be separated and concentrated it would be equivalent to a gross power of under 40kW.

Radioactive Elements Produced by Neutron Bombardment.—A number of elements can be made radioactive by neutron bombardment. Those most suitable for irradiation have a large cross-section for neutron capture and give high-energy γ-rays on disintegration. They can be divided into two classes, depending on whether the isotope has a short half-life, and so must be used at the reactor, or a long half-life, so that it can be used anywhere. In the first class the most suitable elements are sodium, manganese and indium, and in the second, cobalt.

(*f*) Sodium-cooled reactor. In a reactor cooled with liquid sodium, it would be possible to circulate the coolant through an irradiation cell, while the sodium 24, formed by neutron capture in the reactor, could provide the γ-ray source as it decayed back to the normal sodium 23. This need not interfere with the operation of the reactor, the radiation level would vary with reactor power level, but with a considerable time lag, owing to the fifteen-hour half-life.

(*g*) Induced activity in circulating liquid. If solutions of salts of manganese or indium are circulated first through a reactor and then through an irradiation cell, the manganese 56 or indium 116 produced by neutron capture in the reactor will decay in the irradiation cell. A special reactor would be needed for optimum operation, and such a one was planned for the Quartermasters' Division of the United States Army, using indium-sulphate solution as the circulating material.[28] It is understood that initial estimates of the cost proved to be too low, and the project has been dropped. It is to be replaced by an irradiation facility[29] using cobalt 60.

(*h*) Cobalt 60. The long half-life of over five years, the high activity possible, and the reasonably high γ-ray energy produced, make cobalt 60 the most suitable of all isotopes for irradiation, but the restricted facilities for its production and high cost reduce the probability of its becoming commercially attractive. The annual production of cobalt 60 in this country is not revealed, but the largest single source reported is one of 10,000 curies at Wantage.[30] The present published cost of cobalt 60 is about £2 per curie, or £140 per watt. The current annual production of cobalt 60 in the United States is reported to be 300,000 curies, and the largest single unit outside Oak Ridge is one[29] of 62,000 curies, or about 1kW. The cobalt 60 unit for the United States Quartermasters' Corps is planned to use about 2 mega-curies, and production will have to be stepped up if that is to be achieved in a reasonable time. The present price of cobalt 60 in the United States is understood to be 2 dollars to 9 dollars per curie, depending on activity. Statements have been made that the price of cobalt 60 should come down to 6 cents per curie, but a more realistic survey estimates a minimum price of 35 cents per curie,[31] when produced in a special reactor. The latter figure represents 24,000 dollars per gross kilowatt.

The most detailed estimates published to date on the possible schemes for the use of radioactive isotopes for large-scale irradiation are given in a report of the Quartermasters' Division of the United States Army.[26] This considers all the schemes given above with the exception of that for cobalt 60.

Problems of Industrial Application

The main problems to be solved in applying irradiation sources for industrial use are those of achieving a uniform dose rate and maximum utilisation of the radiation power available, dose measurement, and shielding and protection for personnel. Some of these tend to differ for γ-ray and electron sources, and will be dealt with separately. In addition, there may be problems of cooling of the material when subjected to large doses.

[The author discussed these problems in some detail and described the methods of applying electron radiation in practice.]

Economics of Irradiation

The factors of greatest interest, from an economic point of view in planning an irradiation unit, are the capital cost of the equipment per kilowatt of useful power, and the running cost per kilowatt-hour, or per megarad-lb of potential dose.

Electron Accelerators.—Figures are available to make accurate estimates of the costs of irradiation using existing accelerators, and an estimate can be made as to the future trend. The capital cost of available machines is given in Table I and it can be seen that this varies between £4300 and £57,000 per kilowatt.

Taking a 5 MeV 5kW linear accelerator as typical of the type of machine suitable for large-scale irradiation, the author has made an estimate of the cost of various irradiation processes.[32] The various items contributing to the running costs are given

Table III—*The Cost of Irradiation Using a 5kW Electron Linear Accelerator*

Process	Typical dose	Estimated utilisation	Capacity of 5kW machine per hour	Approximate basic cost of treatment*
	Megarad	Per cent		
Prevention of sprouting (potatoes)	0·01	50	90 tons	1s. 6d. per ton
Disinfestation of grain	0·05	80	28 tons	4s. 8d. per ton
Preservation of foodstuffs	0·05†	45	16 tons	8s. 6d. per ton
	0·5‡	45	3600 lb	¼d. per lb
Sterilisation of drugs	2	80 (in bulk)	1600 lb	1d. per lb
		5 (in phials)	100 lb	1s. 4d. per lb
Vulcanisation of rubbers	5	80 (in bulk)	640 lb	2½d. per lb
		25 (mouldings)	200 lb	8d. per lb
Treatment of plastics	25	80 (in bulk)	130 lb	1s. per lb
		25 (mouldings)	40 lb	3s. 4d. per lb

* Machine running eight hours per day, five days per week. † Low dose. ‡ High dose.

in Table II, from which it can be seen that the overall cost is 27s. per kilowatt-hour, or 0·4d. per megarad-lb. This is assuming operation for eight hours per day, five days a week. Continuous operation would reduce the cost to about 13s. per kilowatt-hour, or 0·2d. per megarad-lb. Even at the higher figure, the cost of treatment is quite low for many applications, and Table III shows the cost and quantity of material that can be treated per hour, for a number of cases. Other estimates[36, 31, 33] put the cost of electron irradiation at 0·08–1·0d. per megarad-lb, depending on the size and type of machine.

Future developments are likely to result in the simplification of the existing sizes of machines, and the production of larger machines, which should bring down still further the cost of treatment.

γ-Ray Sources.—It is much more difficult to make an estimate of the cost of irradiation from γ-ray sources, since there is, at present, no source large enough to be of industrial importance, although at least one is under construction.

Owing to the low dose rate and consequent long hold-up time, the irradiation cells for isotope sources would have to be very large and the conveyor system quite complicated. In addition, some equipment must be provided for handling the source and removing it when maintenance or recharging is required. Because of the high capital cost of the cell and such equipment, estimates show that, even if the isotopes were to be given away free of charge, the cost of using them would probably exceed the present-day cost of irradiation with electron beams, except for very-low-power installations.

Conclusion

The potential success of many processes involving the use of irradiation was demonstrated at least five years ago; the techniques for the production and application of the radiation have been developed, and it can be produced at an economic price. However, the number of industrial installations is very small. Those known to the author are given in Table IV:

Table IV—*Industrial Installations*

7 MeV 3kW linear accelerator	Sterilisation of surgical sutures
2 MeV 1kW Van de Graaff	Sterilisation of drugs
1 MeV 5kW resonant transformers	Cross-linking of plastic wire coating and strip
2 MeV 5kW resonant transformers	Cross-linking of plastic wire coating and strip
1 MeV 5kW resonant transformer	Cross-linking of plastics
1 MeV 5kW resonant transformers	Manufacture of "Irrathene"
2 MeV 10kW resonant transformers	Manufacture of "Irrathene"

The reasons for the slow growth of industrial irradiation seem to be as follows:

(*a*) The reluctance of industrial organisations to incur the capital cost until someone else has proved the process on a large scale.

(*b*) High-power machines with the high energy necessary to penetrate a reasonable depth of material have only recently become available.

(*c*) A number of applications, such as the sterilisation of drugs, may require change in Laws and Regulations to enable radiation processes to be used.

(*d*) Fear of the discovery of new chemical processes which might render irradiation unnecessary.

(*e*) Unrealistic statements about the low cost and availability "in the near future" of large isotope sources.

In order to overcome at least partly, the first difficulty, a centre for pilot-production irradiation has recently been opened.[34] Manufacturers can try out suitable processes on a small scale without the capital expense of purchasing a machine. Other units equipped with conveyor systems and available for pilot production are given in Table V.

Table V—*Installations with Conveyor Systems Suitable for Batch or Pilot Production*

4 MeV 0·6kW linear accelerator	Rental for all processes
2 MeV 0·5kW Van de Graaff	Cross-linking of plastic wire coating and strip
2 MeV 0·6kW Van de Graaff	Cross-linking of plastic wire coating
4 MeV 2kW linear accelerator	Rental for all purposes
3 MeV 3kW Van de Graaff	Treatment of plastics
2 MeV 0·5kW Van de Graaff	Rental for all processes
8 MeV 1kW linear accelerator	Rental for all purposes
8 MeV 2·5kW linear accelerator	Rental for all purposes

A number of the processes for which irradiation is suitable, such as the disinfestation of grain, the prevention of sprouting of potatoes and the vulcanisation of silicone rubbers, can already be carried out by chemical means, but it can be shown that, for large quantities, irradiation can be the cheaper method.

It is likely that electron accelerators will become simpler and more powerful in the future, and tend to reduce the cost of irradiation still further. On the other hand, if the experiments to produce power from fusion reactions are successful, present estimates of future supplies of isotopes may have to be reduced. The isotope power available may have to be reserved for special cases where material of considerable thickness needs to be irradiated.

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Acoustic Research Station

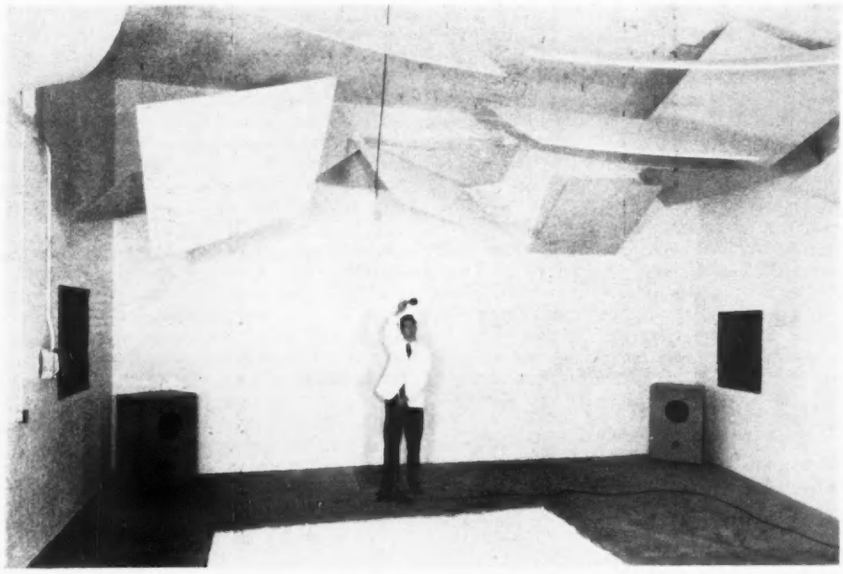
There has been built at Hemel Hempstead a research station to provide measurement and consultancy services on acoustic effects. Fundamental research will be financed from the proceeds of this work.

An independent organisation for practical investigation and research into noise problems, Acoustical Investigation and Research Organisation, Ltd., has now occupied a research station on the trading estate at Hemel Hempstead. A relatively small building, the acoustic research station is distinguished by having built on to its front a gantry for the removal and replacement of floor sections weighing 5 tons: these sections are laid at first floor level so that the transmission of simulated footstep noises can be observed below, in the reverberation chamber. On two sides of the reverberation chamber are the anechoic chamber and the source chamber, the former, like the reverberation chamber, insulated completely from the structure of the building and resting on rubber mountings. The source chamber is the origin of test noises and does not need to be insulated: it is irregularly shaped and finished in high gloss paint, while diffusion of sound is achieved by suspended plastic reflector plates in irregular array, the first example of this technique in this country. The anechoic chamber is also unusual: instead of being enclosed by wedges it is hung with drapes of "Bondacoust," which are more easily applied, less liable to impact damage, and more easily moved for access to doors, electric switches, and so on. The floor of this chamber, as can be seen, consists of steel grids: for work at high frequencies these grids are removed.

The final chamber is a duct, 40ft long and 3ft square, buried outside the station for measurements at very low frequencies. Twenty feet of it is occupied by absorptive wedges to give the effect of infinite length, and these wedges can be blanked off with a reflector, making a standing wave tube for normal absorption measurements.

The function of these chambers can be understood by consideration of the main classes of work undertaken.

(1) *Measurement of Sound Absorption.*—A.I.R.O's laboratory is equipped to measure the sound absorption coefficients at random incidence of any material over the audible frequency range 40 c/s–10,000 c/s. In the case of frequencies at or above 100 c/s, these tests will be carried out in the reverberation chamber, according to British Standards, and in conditions identical to those at the National Physical Laboratory, using samples of 100 square feet placed on the floor of



The reverberation chamber showing the shallow pit to accept 100 square feet samples of sound-absorbent materials

the chamber. Measurements of the chamber's reverberation time with and without the sample enables the absorption coefficient of the material to be calculated. Measurements of the sound absorption coefficients of materials at frequencies below 100 c/s will be carried out in the underground duct using the normal standing wave technique. There are also facilities for measuring the sound absorption coefficients of materials at normal incidence in the frequency range 125 c/s–4000 c/s using the same technique in a standing wave tube in the laboratory.

(2) *Sound Transmission and Sound Insulation.*—An important facility offered is the testing of sound-reducing partitions and windows, either from the point of view of their construction or the materials used.

For example, in testing partition materials and constructions, the experimental sample is placed in the test aperture between the reverberation chamber and source chamber. An accurate measurement can then be taken of the airborne sound transmission loss characteristics of any type of partition at one-third octave intervals in the frequency range 40 c/s to 10,000 c/s according to B.S.S. 2750 : 1956.

Similar measurements can be made for sound reducing floors and ceilings. In this case the test sample is placed in the aperture between the upper source chamber and the reverberation chamber. The efficiency of a floor or ceiling in reducing the transmission of impact sound, such as is caused by, for example, footsteps or machinery, can also be measured.

In testing window constructions under normal conditions the sample is placed in the aperture between the reverberation chamber and the anechoic chamber, since the anechoic chamber gives the effect of open air conditions outside a window.

(3) *Noise Characteristics of Machines.*—Measurement of the noise characteristics of all kinds of mechanical and electrical machines and components will be carried out in the laboratory. The reverberation chamber, the anechoic chamber and the underground duct will all be employed to calculate sound power levels and spectral analysis of machine noise in the frequency range 20 c/s to 20,000 c/s at frequency intervals of from one-third octave to one-fortieth octave as required. Directivity patterns and polar diagrams can also be produced.

In particular, the noise characteristics of all types of ventilation plant can be measured. Fan speeds can be varied within wide limits, and measurements can be taken under given suction or discharge pressure conditions. Where overall sound power levels are to be determined, the test fan will be mounted in the reverberation chamber. Alternatively, the test plant can be mounted in the anechoic chamber to enable directivity characteristics to be measured in open air conditions. Ventilation plant may be tested either working into free air or with duct work installed at suction or/and discharge sides.

The laboratory will also investigate the problems of noise generation by all types of machines, and projects involving the reduction of noise in specific mechanical devices will be undertaken.

(4) *Vibration.*—The laboratory is fully equipped to carry out detailed measurements of all the parameters of mechanical vibrations, spectral analyses of vibration acceleration, and determination of velocity and displacement. The problems of vibration isolation can be fully investigated and resolved.

The anechoic chamber is lined with yielding plastic material, and the steel grid floor is removable

(5) *Electro-Acoustics.*—A major activity at the laboratory will be the measurements and calibration of all types of electro-acoustic transducers, in particular microphones and loudspeakers.

Measurements of the sensitivity of all types of microphones will be carried out in the anechoic chamber at any required range or incidence. Free field microphone frequency response measurements can be taken over the frequency range 20–20,000 c/s and the response can be measured either as a continuous function of frequency or as point-to-point measurements, at frequency intervals which can be as close as one-fortieth octave apart. Free field measurements at frequencies above 100 c/s will be carried out in the anechoic chamber and measurements at frequencies below 160 c/s will be made in the underground duct. An alternation technique will be used.

Full facilities are also available for the determination of microphone directivity characteristics, and sets of polar diagrams can be produced for all frequencies under free field conditions.

The laboratory standard reference microphones will be periodically calibrated at the National Physical Laboratory. In addition, absolute reciprocity calibrations will be carried out frequently in the laboratory.

Comprehensive measurements on the performance of loudspeakers under free field conditions can be undertaken in accordance with B.S.S. 2498 : 1954. The measurements include : sensitivity, frequency responses, mean spherical responses, polar responses, impedance measurements, transient responses, non-linear distortion, efficiency.

These measurements can be carried out in the frequency range 20–20,000 c/s. Frequency response curves will be produced on the basis of either point-to-point measurements or continuous frequency responses, whichever is required.

To simulate free field conditions, the loudspeaker will be placed in the anechoic chamber. At frequencies below 160 c/s the underground duct will be used.

The laboratory will also undertake research on the design of loudspeakers.

Measurement can be made of the performance of many other types of electro-acoustic transducers—such as artificial ears and telephones—and of audio-electronic instruments, such as tape recorders and reproducers, amplifiers, &c.

To undertake these various forms of acoustic analysis, the laboratory is equipped with an extensive range of measuring devices of high accuracy.

As a signal generator, a Bruel and Kjaer type 1014 beat frequency oscillator is employed. This instrument can scan a frequency range 20–20,000 c/s and extremely accurate selection of frequency is possible. For many applications—for example, reverberation chamber measurements—generation of " warble " tone rather than " pure " tone is required, and this is available on this instrument, the modulation being continuously variable up to 200 c/s at modulation frequencies of 1–32 c/s.

The output from this oscillator will be amplified through an extremely linear amplifier and fed from loudspeakers. In the case of both the reverberation chamber and the source chamber, a number of loudspeakers are placed in positions which will ensure adequate diffusion of sound in these rooms.

The microphones to be used in the laboratory are of two classes :

(*a*) Moving coil " ball and biscuit " for use in the reverberation chamber, source chamber and underground duct.

(*b*) Condenser microphones used in the anechoic chamber and others used as laboratory standard microphones.

Analyses of noise, &c., are carried out by feeding the signal from the microphone through either a Bruel and Kjaer type 2109 one-third octave spectrometer or a Bruel and Kjaer type 2107 peak frequency analyser, depending on the specific requirement.

Frequently the one-third octave spectrometer is more suitable, as in reverberation chamber absorption tests, standard sound transmission loss tests, &c., but in cases where close frequency content analyses are required, the peak frequency analyser is essential, as in spectra of machinery harmonics, exact determination of panel resonances, &c.

The output from the one-third octave spectrometer or peak frequency analyser is frequently connected to a Bruel and Kjaer type 2304 high-speed level recorder, which plots graphically the voltage passed by the filters. Thus, permanent records of noise spectra, of reverberation decay, and of frequency responses, can be retained.

A very important feature of the oscillator, one-third octave spectrometer, peak analyser and high-speed level recorder, is that they can be coupled together mechanically and driven simultaneously by the level recorder motor. Thus, by locking the oscillator frequency and one-third octave spectrometer (or peak analyser) frequency and using suitably calibrated recording paper, many of the measurements can be carried out automatically over the entire frequency range. The resultant saving of time and elimination of the possibility of human error are obvious advantages.

When vibration measurements are to be carried out, a Bruel and Kjaer type 1606 accelerometer is used instead of a microphone, and by connecting via a preamplifier to the one-third octave spectrometer or peak analyser vibration spectra can be obtained. Suitable integrating networks in the preamplifier enable acceleration, velocity or vibration acceleration to be indicated directly.

Normal incidence absorption measurements are carried out in a standing wave tube. A loudspeaker is rigidly mounted at one end and the test sample at the other end. A probe microphone moving longitudinally inside the tube explores the resultant plane wave for maxima and minima. Connection of the microphone to the one-third octave spectrometer enables the absorption coefficient of the test material at any frequency to be read directly on the spectrometer meter. A tube 100cm in length is used for measurement of frequencies in the range 125 c/s to 1200 c/s, and a tube 28cm long is used for measurements in the frequency range 1000–4000 c/s.

Developments at Scotstoun

The aerial view of the Scotstoun yard of Yarrow and Co., Ltd., below, illustrates the compactness of the shipyard and engine works where, during the last five years, a considerable amount of reconstruction and reorganisation has taken place. This work has been undertaken to improve efficiency, speed up production and enable the company to meet the increasingly severe foreign competition. Also forming part of the scheme is a new building to house the staff of the Yarrow-Admiralty Research Department which is engaged on Admiralty sponsored research related to both steam turbine and nuclear machinery.

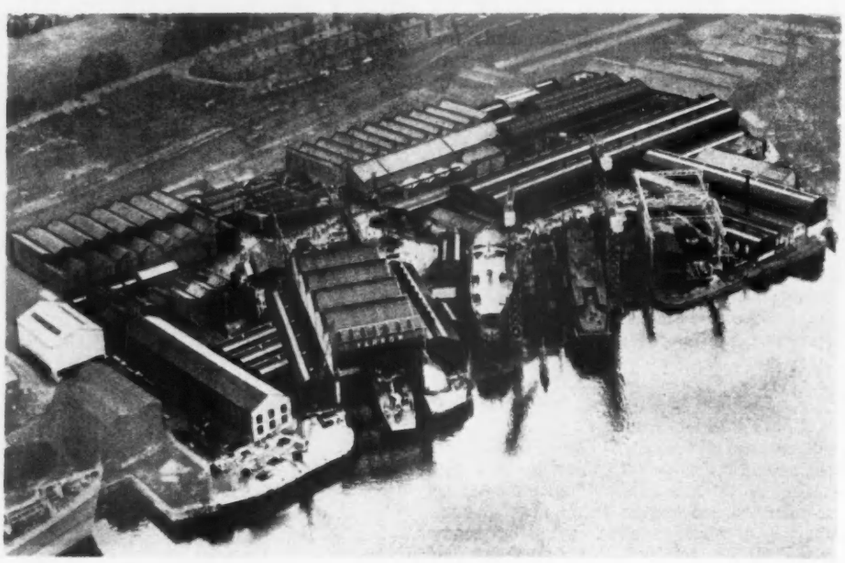
LAST week we attended the launch of the " Whitby " class anti-submarine frigate H.M.S. " Brighton " from the yard of Yarrow and Co., Ltd. The ship, the third to bear this name, has a standard displacement of over 2200 tons, an overall length of 370ft by 41ft beam and will carry an armament of two 4·5in guns in a twin turret also two 40mm anti-aircraft guns, torpedo tubes and anti-submarine weapons. It is of interest to note that the propelling machinery includes a novel arrangement of geared turbines of advanced design and high power.

Before the naming ceremony, which was performed by Lady Reid, the wife of Admiral Sir Peter Reid, the Third Sea Lord and Controller of the Navy, the opportunity was taken to inspect briefly the many and varied items of reconstruction and reorganisation which have been completed at the company's Scotstoun yard. The work covers a period of five years and represents a capital investment of over £1,000,000 in an endeavour to ensure that the company is adequately equipped to face and surmount the increasing intensity of foreign competition. To mark the termination of the five-year plan and to record the details of the individual improvements effected the company has issued a brochure which is largely pictorial in content, the aim being to illustrate how the space available has been reorganised to improve overall efficiency.

An area of sixteen acres is occupied by the works, which has a river frontage of about 1000ft, and this limited space has called for some ingenuity in planning both to achieve the maximum use of the area available and to carry out the work without adversely affecting production. New machines have been mounted in the engine shop and the boiler shop has been re-equipped to expand its scope, so as to undertake work connected with nuclear power stations. Among the new equipment is a stress relieving and annealing furnace having a temperature range of 650 deg. to 1000 deg. Cent., and a shot-blasting plant to take work units measuring 30ft by 12ft by 9ft. To ultilise adequately the new engineering materials and to permit the employment of modern techniques in the production of machinery using advanced steam conditions of high temperature and pressure requires a correspondingly high standard of checking and testing. To provide this the Inspection Department has been enlarged and supplied with the necessary apparatus. It is essential for overall efficiency that the utilisation of the machines should be high and to ensure this together with a balanced flow of work a production control system has been evolved which progresses the work and makes available the jigs and tools. Another new building houses the gas turbine experimental shop and testing beds.

To expedite hull construction there is a new mould loft, a new sheet metal shop, an extended plater's shop and a prefabrication area, both of which are arranged for economic working and have good access to stockyard and building berths. For fitting-out purposes there is a new brass shop and dockside fitting shop, while to accommodate the ships the wet basin has been extended. This was originally 350ft long, and largely covered, and has been extended by 170ft so that there is space for two ships to be partly completed under cover, while river-side arrangements permit a third ship to be moored across the end of the wet basin for final fitting out. The four building berths are served by four tower cranes each able to lift 10 tons at 90ft radius, while at the wet basin there are two travelling cranes, one to lift 20 tons and the other to lift 50 tons, and a crane to lift 5 tons at 90ft serves the river berth.

The completion recently of a three-storey office block marks a further stage in the development of the the Yarrow–Admiralty Research Department (Y-A.R.D.), which was originally set up in 1946 for the purpose of carrying out investigations into all stages



The Scotstoun works from the air

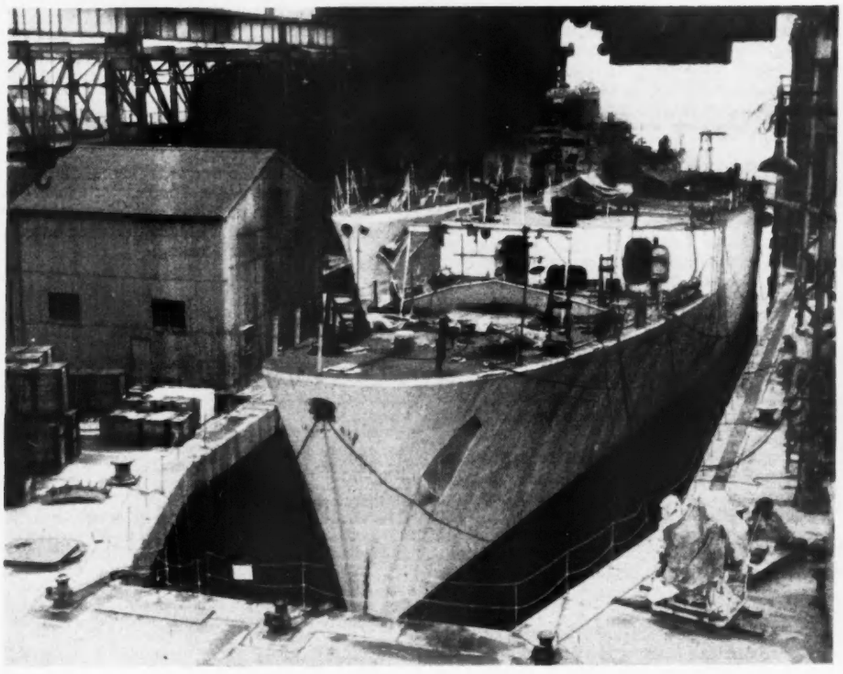
of naval engineering. In the intervening years the volume of the work has extended to include nuclear power and the staff, which is a judicious blend of the academic and the practical, now numbers about sixty engineers competent to design and to institute and carry out research programmes. The staff are employees of Yarrow and Co., Ltd., but the organisation is financed by means of contracts placed by the Admiralty for particular feasibility studies and the preparation of the related reports. As at present constituted Y-A.R.D. acts in the capacity of a consultant to the Admiralty and advises upon the best machinery concept and a balanced lay-out for a particular requirement. The department also advises on marine engineering research and developments, and long-range developments, and is concerned with preparation of specifications and guidance drawings while it is available to assist in conducting full scale shore trials of new designs of machinery.

From the foregoing it will be realised that Y-A.R.D. is not primarily concerned with the design of new equipment but makes use of data provided by experts and other specialists engaged in the production of auxiliaries. For a feasibility study the team makes an analysis of the power requirement based on an examination of the composite picture made up of the varying factors and service requirements to be satisfied. The weight and influence of each item are assessed and a total arrived at which makes due provision for all requirements. This study results in the formulation of a philosophy which satisfies the overall design of the machinery such that the whole has a power range judged to satisfy the specification economically, including boilers of a size to meet efficiently all calls upon them. Furthermore, auxiliaries of economic major size are also chosen to satisfy an accurate assessment.

During recent years the department has developed machinery for the "Whitby" class of frigates, which represents an advance with respect to weight, space and performance. As a result it has been possible to reduce the size of the ships with a corresponding reduction in cost amounting to about 10 per cent against which has to be set research and development charges amounting to about 1 per cent of the capital cost of the frigate programme. Another research contract has been the design and development and shore testing of a 30,000 s.h.p. installation of geared turbine machinery embodying new engineering standards for steam conditions, lightweight gearing and a wide range of oil fuel burning equipment. Automatic and remote controls were incorporated, and air-conditioned control rooms to permit the ship to be steamed under conditions of atomic or gas attack. A design contract which is now practically complete concerns a combined steam turbine and gas turbine installation, in which both are geared to the same shaft, and in which the gas turbine rapidly provides the power, additional to that of the steam turbine, for sustaining bursts of high speed. This machinery is destined for the "Tribal" class of general purpose frigates.

Although Y-A.R.D. is normally engaged on naval machinery the department is available, with Admiralty permission, to assist in the development of merchant machinery. With its resources the department can bring new thinking regarding the analysis of requirements based on a detailed study of schedules, speeds, range of water temperatures, climatic conditions and load demands for ship and hotel services, &c., to produce an envelope of essential maxima and minima to meet all exigencies. Thus the department could advise upon the installation having the optimum thermodynamic efficiency resulting in considerable savings in running costs. It is of interest to note that such assistance has been given in the design of the machinery for the liner "Canberra" at present being built at Belfast by Harland and Wolff, Ltd., for the P. and O. Company. Thus Admiralty sponsored research will, by increasing the operating efficiency of the liner's machinery, assist the owners to fight foreign competition.

A considerable part of the staff of the department have been engaged on comprehensive studies related to the application of nuclear propulsion to a fast replenishment naval tanker, and similar studies are being carried out for application to surface warships. As regards the purely commercial employment of nuclear machinery, Y-A.R.D. has been engaged both in promoting and co-ordinating feasibility studies of various reactor systems. This work has gone forward in collaboration with the Atomic Energy Authority and with several industrial groups. As a result of the studies reports were prepared and models made available in May of this year to a limited audience. All eight reactor systems submitted possessed different characteristics with respect to weight, size, capital and operating costs and a number of other technical factors. Subsequent to the exhibition of the reactor plants in question, several of the systems are being subjected to more detailed examination and comparative studies made in the ship context, to determine which of the several plants can be recommended for application to a merchant ship. Whether the machinery will be installed in a naval fast replenishment tanker or a purely merchant ship is a matter for the Government to decide. Whatever the outcome the work of the Yarrow-Admiralty Research Department will prove of great value to the country since the high degree of integrity of the department has enabled highly confidential commercial information to be examined and assessed with security to the firms concerned.



Two naval vessels berthed in the extended wet basin

National Federation of Engineers' Tool Manufacturers

At the annual general meeting of the National Federation of Engineers' Tool Manufacturers, which was held in London on October 22, Sir Stanley J. Harley was elected president for the coming year. There are now 108 member firms in the Federation and its annual report shows that, in addition to trading and marketing subjects, a close interest is maintained in connection with standardisation. Representatives of the Federation are on nearly fifty committees of the British Standards Institution as well as on I.S.O. working groups.

At the dinner which followed the general meeting the guests were welcomed by Sir Stanley Harley, who said that it was the aim of the Federation to play an ever greater part in the industrial welfare of the country as well as working in the interests of its members. Responding to this toast, Mr. L. Chapman, president of the British Iron and Steel Federation, said that the Federation was recognised as the representative co-ordinating body for the tool industry. It fulfilled its obligations in keeping industry supplied with the tools it required in addition to maintaining a healthy export trade. Mr. Chapman spoke to some length on the effects of the Restrictive Trade Practices Act, which he considered was not beneficial to industry as a whole and would ultimately force small concerns to amalgamate into combines. Under such conditions much individual development work would probably cease and the services now given by small firms would be a thing of the past. The British steel industry, said Mr. Chapman, was live and virile, and the service it provided was as good as any in the world. With regard to shortages of steel, the industry had to make very long-term plans for plant installation and with the best will in the world it could not be expected to foresee and satisfy peak demands which were marginal and often of a temporary character.

Car Radiophone Service in S. Lancs

CAR owners who equip their vehicles with a suitable v.h.f. radio installation are now able, while travelling in a wide area of South Lancashire and adjacent country, to make and receive calls to and from any telephone on the United Kingdom network. The service was inaugurated by the Postmaster-General, the Rt. Hon. Reginald Bevins, M.P., on October 28, by making a telephone call from a car at Lymm, Cheshire, to Lord Rootes, chairman of the Rootes Group and the Dollar Export Council, in London. Before making the inaugural call, Mr. Bevins said the Post Office had three broad aims—to give the public what it wanted at a fair price, to become more and more efficient technically by the use of methods such as those already applied for removing the drudgery from sorting, and to ensure contentment among its staff of more than 350,000 men and women. The new radiophone service, he thought, would prove valuable in activities such as those of the television industry, the press, the motor industry, building contractors and many others. Firm orders to participate in the scheme, for which there was a quarterly licence fee of £7 10s., had been received already from thirty-five applicants.

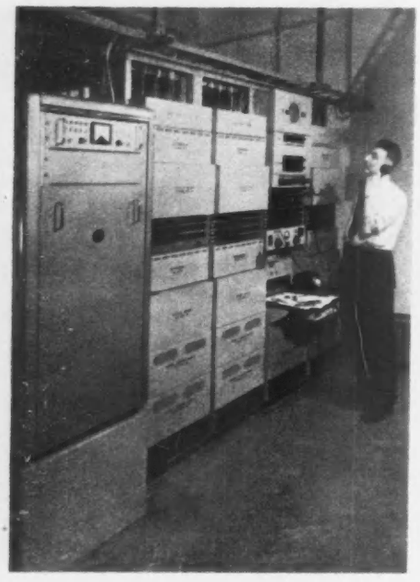


Fig. 1—Auxiliary receiver, line equipment and central control panel for car radio scheme at Manchester

The service area covers the southern half of Lancashire, the Wirral and parts of North Cheshire. The system operates through the Peterloo exchange, Manchester, which is connected by landlines to the two base stations at Liverpool (Lancaster House exchange building) and at Winterhill, near Horwich. Frequency-modulated transmitters and receivers are installed at both these points, and there are auxiliary receivers at Manchester which are connected automatically to the telephone circuit in place of the Horwich base station receivers when better reception can be provided in this way. Five two-way channels are in use at present, the frequencies being as given in our table.

On receipt of a call, the Peterloo exchange operator instructs the vehicle to change to one of the traffic frequencies according to availability. The equipment is suitable for channels having carrier-frequency separations of 50 kc/s, and the same characteristics as have been agreed for the v.h.f. international maritime services have been adopted. These include a maximum deviation of ±15 kc/s, pre-emphasis and de-emphasis of 6 dB per octave within the band 300–3000 c/s, and frequency tolerances of ±2·0 and ±3·0 kc/s for the base and mobile stations, respectively. The power of the base stations is about 35W (E.R.P.); for the mobile stations the power is restricted to 25W (E.R.P.) by licence, but 15W is expected to be employed.

A contract to supply all the fixed station equipment for the scheme was awarded to Pye Telecommunications, Ltd., Cambridge. This includes the radio terminal equipment at Peterloo exchange (Fig. 1), where the four-wire radio circuits are converted to two-wire telephone circuits and provision is made to ensure full modulation of the radio transmitter irrespective of variation within wide limits of the speech volume received from the telephone subscriber. Transmitting and receiving equipment supplied by Pye Telecommunications, Ltd., in connection with the Winterhill, Manchester and Liverpool stations comprises ten 50W transmitters, fifteen receivers and two six-channel, high-power mobile units. The mobile station equipment has been installed at two fixed points and so arranged that limit-of-service conditions are simulated. An operator at these points can make routine test calls via both base stations over all the channels to the operator at the Manchester telephone exchange. The mobile station sets can be switched over all the channels previously mentioned but normally keep watch on the calling channel.

Base station receivers are set to operate on signals which have a signal-to-noise ratio of 25 dB or better and are not disconnected until the signal-to-noise ratio drops to 15 dB. The auxiliary receivers at Manchester are set to operate at a somewhat higher signal-to-noise ratio and once operated they are connected to the telephone circuit in place of the Horwich base station receivers.

The base station at Horwich is approximately 1500ft above sea level and comprises a brick building to house the equipment; in addition, there is a stayed lattice mast, 186ft high, which accommodates separate half-wave dipoles for each transmitter and receiver. At Liverpool the equipment is located at Lancaster House and a stayed lattice mast 86ft high has been provided on the roof. Again, separate aerials are provided for each transmitter and receiver.

Fig. 2—Installation of PTC 8205 transmitter-receiver in car boot

At the inauguration of the service, demonstrations were given of the Pye Telecommunications PTC 8205 five-channel boot-mounting radio telephone for cars, which has received full Post Office approval. Fig. 2 shows this equipment installed in a car boot. It is operated from a dashboard control panel incorporating a loudspeaker on which the user hears calls originating from Peterloo exchange. If addressed to him (call signs consisting of a single letter and three numerals are being allotted at present), he answers by unhooking a handset and pressing a trigger in the handle to switch on his transmitter. He is then instructed to change frequency to one of the traffic channels, which he does by operating a rotary switch to the appropriate channel number. A receiver/stand-by switch is also provided which, when in the "receiver" position, causes the transmitter valve filaments to be switched off to economise in current consumption. If expecting calls, the user would leave the switch at "stand-by" so that his transmitter would be ready for immediate reply.

Channel	Base station	Frequency (Mc/s)	
		Transmit	Receive
Calling ...	Liverpool and Horwich ...	164·05	159·55
Traffic ...	Liverpool	164·1	159·6
Traffic ...	Liverpool	164·25	159·75
Traffic ...	Manchester	164·15	159·65
Traffic ...	Manchester	164·2	159·7

To make a call, the user lifts the handset and presses the trigger in the handle. A carrier is at once radiated and actuates a relay at Peterloo exchange which illuminates a lamp on the board, showing that a vehicle is calling.

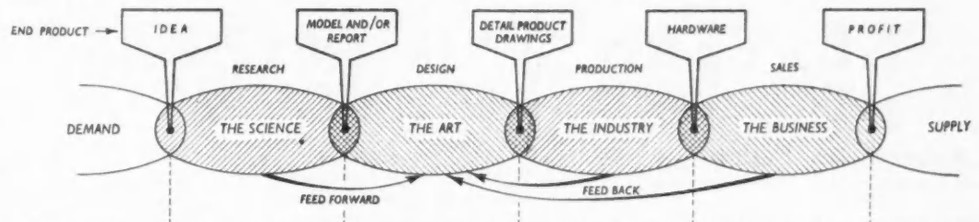
Technical Reports

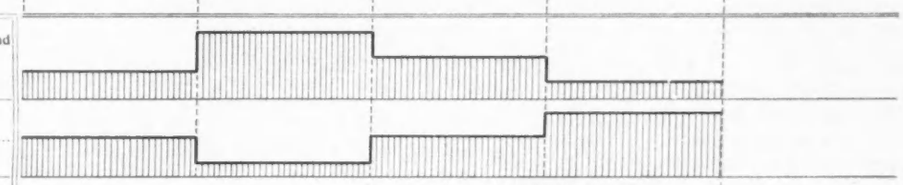
B.S.449 : 1959. An Explanatory Brochure. By Lewis E. Kent, M.I.C.E. British Constructional Steelwork Association, Artillery House, Westminster, London, S.W.1. Price 3s. 6d.—The foreword to this brochure points out that "the onset of new or revised regulations invariably heralds a trying period for the unfortunate people who have to work to them." Thus the aim is to explain, for the benefit of the steelwork designer, the differences between B.S.449 : 1959, and B.S.449 : 1948, which is now superseded. The brochure is set out so that these differences are immediately clear, using a two-column layout to compare the one against the other, and to give cross references in clause numbering and so forth. Design examples further illustrating these differences are also given.

A Critical Survey of Methods for Measuring the Total Gas Content of Water. By E. V. Kanellopoulos. MERL Fluids Note No. 77. Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.—A theoretical analysis is made and the various methods are classified into two categories, the "direct methods" by which the total gas content is directly measured and the "indirect methods" by which the total gas content is computed from measurements of one of the constituents of the gaseous mixture. The only reliable methods in practice are the direct methods. A further method which could give a continuous indication of the total gas content would be an improved thermal conductivity method in which gases are released from water by bubbling hydrogen through it.

Plastics in the Tropics: II. Cast Acrylic Sheet. H.M. Stationery Office. Price 5s.—For this investigation sheets of cast methyl methacrylate, both plasticised and unplasticised, were exposed at four sites in the tropics for more than two years. One of the sites was a permanent building representing a tropical base depot store and a further set of specimens was kept for most of the period in a room with a controlled atmosphere. Specimens exposed in the desert showed discoloration and loss in transparency, particularly in the case of unplasticised sheets. At the two jungle sites there was less colour change and less loss in transparency. At the end of the trial, specimens from all sites had retained satisfactory resistance to impact. Under all conditions of exposure the plasticised materials showed loss of plasticiser of the same order. Specimens stored under base depot conditions remained free from biological attack, but at the jungle sites fungal and algal growths developed. Crazing was noted on specimens exposed in the jungle undergrowth, but this was not apparent under other conditions.

Leadership is not so much telling people what to do, as showing, both by precept and example, how to do it



Probable relative importance as affecting quality and saleability and success of the product				
General regard paid by the country as a whole				
Higher level educational facilities available at Universities, C.A.T.s or elsewhere	Very good	Practically none	Courses at University level in : Work and Method Study, Factory Administration, Production Methods, &c.	Administration, Business Management, Accountancy, Executive Development, Commercial Law, &c.
Professional institutions actively interested at an adequate level	Royal Society, British Association, Royal Institution, Institute of Physics and many others	Institution of Engineering Designers; Any others ?	Inst. Prod. E., Inst. E.E., Inst. Mech. E., &c., P.E.R.A.	Inst. of Management, Inst. of Directors, Inst. of E.E. and Mech. E., &c.,
Trade Associations actively interested	Several	Any ?	Most	All
Journals dealing with it in Britain	Many scientific and technical journals, too many to list	Few if any, perhaps one or two (Several in U.S.A. and Germany)	Large numbers of active Trade, Technical and Advertising journals	
Books published in Britain dealing with it at a high level ...	Many	Few if any	Plenty	Plenty
Representation on Boards of Directors, Higher Management, National and International Committees, &c.	Considerable	Practically none	Substantial	Very large majority
Accommodation and facilities provided for staff...	In General: Good	Poor	These are recognised as the "Paying" Branches and are usually well provided	
Contacts with outside organisations, facilities for development of experience and character	Good in general	Very poor	Much better	Best of all
Career prospects	Promising	Negligible	Much better	Best of all
Financial provision made, e.g. as for	Research Establishment ?	Design facilities, Training and Education ?	Production and Method Study, Metrology ?	Higher Management Studies, Business Admin. ?
Attention paid in Government establishments, D.S.I.R., Scientific, Civil Service, Ministries, &c.	Good and effective	Practically none	Good	Reasonably good

The Anatomy of Industry

AT a very full meeting of the Stafford Works Engineering Society of the English Electric Company recently there was a discussion upon "The Role of the Mechanical Designer in the Engineering Industry To-day." Two invitation speakers were Dr. Hugh Clausen and Mr. Ewen M'Ewen, both of whom have from time to time contributed articles on design to our pages. Talk was free and covered a wide range of higher education, training, and works organisation matters. Dr. Clausen showed a slide—reproduced here—entitled "The Anatomy of Industry" as an attempt to sort out the relative attention paid in this country to the many different aspects of the engineering industry. The basis of his talk was the serious lack of attention paid to "the Art" of engineering as compared with "the Science," "the Industry," or "the Business." He felt that the diagram, though somewhat tentative and open to some criticisms, would show quite a different picture if applied to, say, Germany, Switzerland, Sweden, or U.S.A.

The dominant note of Mr. M'Ewen's contribution was that whereas in medicine, surgery, law, architecture, accountancy, music and painting (among others), all higher education was directed and carried out by men actively engaged in their own professions ; in engineering, where the necessity of such professional guidance was perhaps greater still, the higher levels of education seemed to have fallen into the hands of a self-perpetuating race of professors and teachers who appeared to be drifting further and further away from reality. Dr. Clausen has sent us the comments printed below in explanation of his diagram.

The diagram attached, "The Anatomy of Industry," is an attempt to correlate the importance of the different overlapping and interlocking phases of industry based on the "value for money" aspects of the product, with the relative attention which they get from the country as a whole and from special activities concerned. Examples of such are educational and training facilities, professional institutions, scientific and technical journals and books and industry itself. The relative extent to which these different phases are represented on governing bodies, boards of directors, national and international committees, government and service establishments, &c., are also compared.

Whichever aspect is considered, the phase where the quality of the product is determined—the art—comes out a bad fourth. Some oversimplification is perhaps involved, and the method of display and relative weighting shown may be open to criticism, but broadly and in the main, the result is incontrovertible. Far more attention is paid to the profit than to the product ; although the former will depend on the latter. Our present financial and industrial set-up seems to be based on the principle that "money is the measure of all things." The result of this, and of the increasing financial rather than professional control of industry, is that creative activities are forced down to a level below that at which they can function effectively, and technical leadership is lost. The increasing tendency to manufacture under licence to foreign designs derives from this and, in its turn, erodes our own creative ability still further. When technical leadership is lost, financial and general control soon follow it. An analysis on these lines of the industrial set-up in those countries which are our most serious competitors would show quite a different weighting in the different aspects. We cannot survive by financial or trading activities, only by industry, and what really matters is the product. If due attention is paid to every aspect of this, including selling it, the profit, as a kind of by-product, is almost automatic.

Our industrial prosperity will never be soundly based until this principle is realised, understood and acted on at the highest levels.

Lloyd's Register of Shipping

THE shipbuilding returns issued by Lloyd's Register of Shipping for the quarter ended September 30 show that in Great Britain and Northern Ireland the work in hand amounted to 292 steamships and motorships of 2,097,764 tons gross. During the quarter sixty-three ships of 313,183 tons were commenced, sixty-one ships of 289,571 tons were launched, and fifty-one ships of 250,894 tons were completed. Tonnage under construction for registration abroad amounted to thirty-one ships of 231,512 tons or 11 per cent of the total being built. Out of the total tonnage under construction sixty-four ships of 1,024,890 tons, representing 48·9 per cent, were oil tankers. Abroad, the work in hand totalled 1171 ships of 7,715,793 tons gross and included 1,206,865 tons in Japan, and 968,000 tons in West Germany. The totals of ships commenced, launched and completed during the quarter were respectively : 357 ships of 1,531,820 tons, 362 ships of 1,783,538 tons and 355 ships of 1,550,471 tons. The tonnage building for export amounted to 3,480,120 tons or 45·1 per cent of the total, and included 368,735 tons for Great Britain and Northern Ireland. Oil tankers under construction totalled 235 ships of 4,194,773 tons and represented 54·4 per cent of the tonnage building. Throughout the world 1463 ships of 9,813,557 tons gross were being built, 21·4 per cent of which were under construction in Great Britain and Northern Ireland. Oil tankers under construction totalled 299 ships of 5,219,663 tons gross or 53·2 per cent. Of the steamships and motorships building throughout the world some 5,450,688 tons or 55·5 per cent are to be classed with Lloyd's Register.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

EARNINGS OF ENGINEERS

SIR,—Your congratulations to the Engineers' Guild for publishing the results of the survey, particulars of which appear in the columns of your issue of October 16, are certainly appreciated, but as your subsequent remarks appear to suggest that the Guild has in fact been responsible for an almost completely inconclusive experiment, perhaps you will allow me some further space in your pages to comment thereon.

You say that "the facts revealed by the survey taken by themselves seem to have little significance," but there is really no compulsion on the intelligent reader to take the facts by themselves. Limitations of space and considerations of printing costs made it impossible for the Guild to publish much more than the bare results of the survey, and even these had to be substantially abridged before they came within the compass in which they finally appeared, but it was our hope and intention that they would be studied both for any light they might shed on currently held ideas on the subject, and for comparison with some of the more general social and economic statistics of which a surprising wealth exists for those who know where to look for it.

As for the first, you yourself admit that you "hold much the same ideas about engineers' salaries as the Guild," but presumably you had not previously arrived at this view without forming at least some mental assessment of the likely level of those salaries, the validity of which can now be confirmed or disproved by the results of the survey. As far as the Guild is concerned, our worst fears on the subject are more than confirmed. Are yours, or do you really think that the picture is not, after all, as black as it has been painted ?

The comparison with American conditions is admittedly incomplete without a reference to the general difference in standards of living in the two countries. This is a problem to which we shall undoubtedly address further thought, and if in the end we establish that the British engineer is no worse off than his American counterpart, it will be very satisfactory to be able to tell the members of the profession in this country that, on the whole, they are as well paid as they can expect to be in the current economic circumstances, although I doubt if many of them will really believe it ! I, for one, however, believe that these further researches will only serve to establish the correctness of the Guild's remark that "no reasonable allowance for the differing cost of living in the three countries can remove these disparities."

In the meantime, it is possible to establish, by reference to tables published by *The Economist*, that, for the year to which the survey referred, the average wages for all adult male workers in United Kingdom industry must have been about £600 per annum, or exactly half the median rate for professional engineers established by the survey. When it is appreciated that this average includes the lowest paid labourers and that "adult" means over eighteen, while "professional" usually betokens an age of not less than twenty-five, a factor of two which is subject in any case to a quite appreciable reduction through the effect of graduated taxation, would hardly seem to be an adequate recognition of the increased responsibilities borne and qualifications required, particularly in a country where, according to the *Blue Book* on national income and expenditure, there were at that time over a million incomes above the median income of the professional engineer.

I have given two examples of the type of calculation and comparison which can be made, primarily to illustrate the point that the Guild has not launched its survey into any statistical vacuum, and that it is not necessary to wait until the Guild itself has dotted every statistical "i" and crossed every "t" before "drawing any conclusions." I am, nevertheless, under no illusion that the exercises which I have undertaken above are not highly vulnerable to the kind of criticism to which such exercises are generally subject by persons wishing to prove the opposite point of view.

The answer to the question which you ask : "how, for example, do doctors, architects, lawyers and accountants fare ?" is, in essence, one of the reasons for the appointment of the Royal Commission on doctors' and dentists' remuneration whose existence has made the survey possible, and it may be hoped that much information on this aspect of the matter will be forthcoming when that Commission makes its report. It was, however, on the initiative of the Engineers' Guild, and at its expense, that the survey relating to the engineering profession was enlarged to the extent necessary to facilitate the breakdown among the various branches of the profession, which is not the least interesting part of the published results.

J. H. JELLETT,
Chairman, General Council
Engineers' Guild,
201, High Holborn,
London, W.C.1,
October 24, 1959.

SIR,—With reference to your leader on earnings of engineers in THE ENGINEER for October 16, 1959, the following study of published income-tax figures for Great Britain and U.S.A. give a fair idea of the relative value of money in the two countries. The actual figures relate to 1954 but the ratio is not likely to have altered very much.

Incomes, per cent	U.S.A., dollars	Incomes, per cent	Great Britain, £
33	0–2,500	33·4	0–250
36	2,500–4,750	36·4	250–500
22	4,750–7,500	20·6	500–750
5	7,500–10,000	5·37	750–1,000
4	Over 10,000	4·23	Over 1,000

The figures are not strictly comparable as the coverage in the two countries is not necessarily precisely the same, but I think it is fair to assume that for every £1 of income one has over here one would need about 10 dollars to be in a similar financial position in the U.S.A.

E. M. ACKERY

London, S.E.26,
October 26, 1959.

Book Reviews

L'Année Ferroviaire 1959. With contributions by H. ROUSSELIER, J.-M. GOURSAT, R. LEVI, C. MARTIN, L.-M. JOUFFROY, J. MOTHES and the Service Technique of the S.N.C.F. Paris : Librairie Plon, Les Petits-Fils de Plon et Nourrit, 8, rue Garancière, (6e). Price Fr.990.

EVERY year since 1947, the railway yearbook *L'Année Ferroviaire* has appeared with articles by a number of experts from the technical and administrative services of the French Railways and others. In this year's edition the Departmental Head of the Office of Economic Expansion at the Ministry of Finances and Economic Affairs, deals with the role played in the present export drive by technical improvements in rolling stock and installations. The manager of the Northern Region of the S.N.C.F. details the problems which arose in connection with the electrification of that part of the French network. Electronics are increasingly applied and that aspect is described by the Directors of Fixed Installations, and of Rolling Stock and Traction. A historical review of 2000-year-old Lyon contains an appreciation of the city's function as a traffic centre. The volume is rounded off by an article by the Chief of Operational Research of the S.N.C.F. on the applications of this technique in connection with railway management.

Books Received

Expansion and Efficiency. British Productivity Council, 21, Tothill Street, London, S.W.1. Price 5s.

On Helical-Spring Suspension. By Lars G. Lidin. Chalmers Teknisa Högskolas Handlingar, Gothenburg, Sweden. Price Kronor 15.

Ultimate Particles of Matter. Second edition. By D. T. Lewis. Chantry Publications, Ltd., 63, Neal Street, London, W.C.2. Price 15s.

Fifth International Conference on Hot Dip Galvanizing. Zinc Development Association, 34, Berkeley Square, London, W.1. Price 60s.

The Prof, A Personal Memoir of Lord Cherwell. By R. F. Harrod. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 25s.

Calcul a la Flexion des Coques Coniques. By S. Casacci and J. Bosc. Dunod Editeur, 92, rue Bonaparte, Paris, (6e), France. Price Fr.1.800

Corrosion and Deposits in Coal- and Oil-Fired Boilers and Gas Turbines. Pergamon Press, Ltd. 4 and 5, Fitzroy Square, London, W.1. Price 50s.

Absperrorgane in Rohrleitungen. By W. Volk. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz, 3, German Federal Republic. Price DM.25.50.

Principles of Electronic Instruments and Instrumentation. By G. R. Partridge. Sir Isaac Pitman and Sons, Ltd., Parker Street, London, W.C.2. Price 40s.

Introduction to Probability and Statistics. By B. W. Lindgren and G. W. McElrath. The Macmillan Company, New York, 10 ; South Audley Street, London, W.1. Price 44s.

SHORTER REPORTS

Local Employment Bill

LAST week, the Local Employment Bill was presented to the House of Commons. The object of the Bill is to make provision to promote employment in localities in England, Scotland and Wales where high and persistent unemployment exists or is threatened. The explanatory and financial memorandum on the Bill is reprinted here. The Bill repeals the Distribution of Industry Acts, 1945 to 1958, and replaces their provisions by increased powers for providing employment in any locality in Great Britain where high unemployment exists or is imminent and is likely to persist. Part I (Clauses 1–16) sets out the powers (exercisable for a period of seven years) conferred on the Government for the purpose of providing local employment and establishes Corporations to assist in the exercise of the powers ; Part II (Clauses 17–21) amends the legislation relating to industrial development certificates ; and Part III (Clauses 22–28) contains general and supplementary provisions.

PART I

Clause 1 provides that the powers for promoting employment are to be exercisable in any locality of high unemployment. Such a locality is defined as a locality in which the Board of Trade judges that a high rate of unemployment exists or is imminent and is likely to persist (whether seasonally or generally), including places to which workers in these localities would travel to work or to which they might move under " overspill " arrangements.

Clause 2 empowers the Board of Trade, in order to further the provision in any locality of high unemployment of premises in which undertakings may be carried on, to acquire land, where necessary by compulsory purchase, and to erect buildings and carry out works on land belonging to the Board, and also with the agreement of the owner to erect buildings and carry out works on other land.

Clause 3 gives the Board of Trade a new power to make grants to persons carrying on or proposing to carry on undertakings in localities of high unemployment to assist them in the capital cost of building or extending their premises. The grant is to be at a flat rate of 85 per cent of the difference between the estimated cost of a suitable building and the estimated value of such a building when completed. Before making a grant the Board is required to consult an advisory committee.

Clause 4 provides that the Board of Trade may make loans or grants, in accordance with the recommendations of the advisory committee, to persons carrying on or proposing to carry on undertakings in localities of high unemployment. The advisory committee is to be given general directions as to the terms on which its recommendation should be made.

Clause 5 makes provision with regard to derelict, neglected or unsightly land in a locality of high unemployment. Where the Board is satisfied that it is expedient to do so for the purpose of providing employment in the locality the Board may acquire the land and carry out work on it to enable it to be brought into use or to improve the amenities of the neighbourhood, or the Minister of Housing and Local Government (or the Secretary of State for Scotland), with Treasury consent, may make grants to local authorities to assist them to acquire the land and carry out work on it for the same purposes.

Clause 6 enables the Minister of Labour to make payments towards the cost of the removal and resettlement of key workers and their dependants.

Clause 7 enables the appropriate Minister to give financial assistance towards the improvement of basic services in a locality of high unemployment.

Clauses 8 to 13 relate to the constitution and functions of the Industrial Estates Management Corporations of which there are to be three, one each for England, Scotland and Wales. Each Corporation is to consist of a chairman and four other members appointed by the Board of Trade and to include persons experienced in accountancy, building or estate management. The Corporations will have development and management functions which will be exercised in accordance with directions given by the Board to whom they are to account and report. The activities of the Corporations will be co-ordinated by a committee which will give general advice to the Board on matters of common interest to the Corporations or on matters relating to their functions. All the leasehold properties of each of the present industrial estate companies and all the rights and liabilities of those companies are transferred to the appropriate Management Corporation. The freehold properties of those companies (and similarly held properties in Scotland) are transferred to the Board of Trade.

Clause 14 makes provision as to the compulsory acquisition of land.

Clause 15 makes provision when a locality ceases to be a locality of high unemployment. Arrangements for erecting buildings and making grants or loans can be completed and certain powers can be exercised in relation to land acquired by or vested in the Board under the Bill.

PART II

Clauses 17 to 21 relate to industrial development certificates under the Town and Country Planning Acts of 1947. In considering whether or not to grant such a certificate the Board of Trade is to have particular regard to the need for providing employment in localities of high unemployment. Moreover, an industrial development certificate will be required in the case of a proposed change in the use of a building from a non-industrial to an industrial use. Minor amendments of the certification requirements are made in the case of industrial buildings.

FINANCIAL EFFECTS OF THE BILL

The expenditure under the repealed Acts for the last three years has been about £6,200,000 for 1956–57, £3,400,000 for 1957–58, and £4,200,000 for 1958–59. It is not possible to form any estimate of the increase in expenditure which is likely to be incurred as the result of the Bill.

Appraisal of the Rejected Staines Bridge Design

THE controversy between the Ministry of Transport and the Alderton Construction Company over the Bell Weir bridge at Staines was reported in our issue of October 23 last, and commented upon in a " leader " in our issue last week. The Alderton Construction Company asked two Danish professors, I. G. Hannemann and B. J. Rambøll, both of Copenhagen University, to assess the company's design for the bridge, which, it will be recalled, was criticised by the Ministry. The two professors have written a report, in English, the substance of which is given hereunder.

" We have evaluated the project's principles of design and undertaken detailed calculations of essential construction members. We have, further, through the instrumentality of the Geoteknisk Institut (Institute of Soil Mechanics) of the Technical University of Denmark, undertaken an evaluation of the settlement conditions of the pile foundations. The conclusions drawn from our examination may be summarised as follows :

" The project rests on the cantilever principle. The bridge consists in the middle of a suspended span, the beams of which are supported by cantilever arms. The suspended beams are provided with fixed bearings at one end and with expansion bearings at the other. The cantilever arms project from two pile foundations on either bank and are provided with counterweights shorewards. In this design the foundations are only influenced by vertical forces. The design used is statically determinate, such that settlements, including differential settlements with concomitant angular motions, may occur without additional effects and thus without dangerous stresses in the construction.

" The settlements calculated by the Geoteknisk Institut are of no consequence to the said design and may be largely counteracted by the establishment of a slight excess rise.

" By contrast, a two-hinge arch like that of the preferred tender will influence the foundations with horizontal forces. If the ratio of rise to span is small, as in the project preferred (1/9·8), the horizontal forces become proportionally great. Where the foundation conditions, as in the present case, are less good, it will result in foundations of considerable dimensions. Nevertheless, horizontal settlements with concomitant additional stresses will not be avoided. Any trussing between the arch and the bridge deck will increase such stresses.

" In the alternative project the foundation can therefore be made substantially simpler than in the project preferred. Regarding the piling, we would remark that according to the Geoteknisk Institut's statement, it is necessary if the safety factor is put at 2, to increase the pile foundation. This increase amounts to 77 per cent in the original quantity of concrete used for piles, or the increase amounts to 18 per cent over the offer in the contractor's letter of September 4, 1959. If the factor of safety is put at 1·7 no increase is required. This factor of safety can be accepted provided that a test loading gives a satisfactory result. In the Geoteknisk Institut's statement it is mentioned that a safety factor of 1·5–2·0 seems to be required in England.

" The alternative design envisages the use of precast units to the largest possible extent. The units will be assembled and connected to each other by prestressed cables. This principle of construction has been used for several bridges over a number of years and must be held to be suitable for the bridge in question. It has, among others, the advantage of reducing the construction time appreciably. The project is not finally worked out in all details and further consideration of details will give occasion for certain corrections. However, the principle will not be shaken and the project at hand will form an excellent basis for the preparation of a detailed project.

" It is our general impression that the alternative project is up-to-date and the techniques available to-day have been utilised with skill and imagination. We find this bridge a sound piece of work and prepossessing in both the static mode of operation and structural design."

Underground Test Explosions

THE Prime Minister told the House of Commons on July 30 that Her Majesty's Government had decided that tests involving small underground firings of conventional explosives should be carried out in the United Kingdom. These tests were to be made to obtain information on the detectability of small underground nuclear explosions. The Prime Minister added that every possible precaution was to be taken to ensure that there was no damage to persons or property ; and he emphasised that no nuclear explosive was to be used and that, therefore, there would be no release of radioactivity. The United Kingdom Atomic Energy Authority, which has been given the task of carrying out the tests, has now selected, in conjunction with the Atomic Energy Division

of the Geological Survey, a suitable site for the first series of tests. It is a disused mine shaft in the Kit Hill area, north of Callington, Cornwall. The agreement of the Duchy of Cornwall, the owner of the mine, and of the other local interests concerned has been obtained. Preparations at the site will begin shortly and the firings will take place in two or three months' time. These firings will be charges of a size which, fired at the depths proposed, cannot possibly cause any damage at the surface.

Mineral Dressing Laboratory

THE mineral dressing laboratory which has for some thirty years been part of the research laboratories of The General Electric Company, Ltd., at Wembley, was recently transferred to the company's mechanical engineering works at Erith, Kent. This move, which is coupled with a reorganisation of the mining department at Erith, has allowed an extension of the laboratory facilities and brought it into closer co-operation with the engineering and sales departments. The primary function of the mineral dressing laboratory is the investigation of problems in connection with new mining projects or mine reorganisation and expansion schemes. In such schemes the separation equipment is the key to economic production and it is the function of the laboratory to determine the process or combination of processes which will give an adequate recovery of a product to meet market specifications or the demands of a smelter. For this purpose the new laboratory is staffed and equipped to carry out practically all ore treatments and coal preparation processes.

The laboratory is laid out on two floors, one end of the building being used for wet work, as shown in our illustration, and the other for dry. Offices and a balance room are situated on the upper floor and there is a small workshop on the ground floor. Much of the equipment installed is portable and has been designed for plugging in at any convenient point so that machines can readily be assembled into various combinations, such as a rod or ball mill, classifier, circulating pump and feeder. All equipment is kept ready for use at short notice so that attention can be concentrated on the technical aspects of ore treatment without loss of time in devising ways and means of linking up the various units.

In the laboratory, primary crushing of materials is performed in a jaw crusher which can take pieces of up to 2in. If a large batch of material has to be broken down, the product from the jaw crusher can be discharged directly into a "Sherwen" spiral conveyor in which it is elevated to a "Sherwen" screen, so that crushing and screening is completed in a single operation. Secondary crushing can be carried out with rolls if desired, but as the jaw crusher can easily make a product suitable for ball or rod mill feed, rolls are seldom used. A disc grinder which is available for fine grinding of assay samples is not used for preparing ores for treatment.

Coarse ore can be treated by heavy-medium separation or in a jig. The heavy-medium separation equipment is a very effective machine with a 20in diameter separating cone, a "Sherwen" screen and a "Wilfley" pump. Ferrosilicon or magnetite are normally used for making the medium in which separation takes place, and a separating density as high as 3·5 can be reached. On this equipment feed up to ½in and occasionally up to ¾in in size can be treated. The jig unit works well with ¼in feed but is too small to take larger material.

Concentration of fine ores and coals can be carried out in "Humphreys" spirals, on a shaking table or by flotation. These spirals are full-size commercial equipments which can be run either with a continuous feed or, for relatively small samples, with a batch feed in a closed circuit. The table installed is a small-scale machine for continuous running, with circulation of middlings if required, whilst flotation is carried out in batch cells of various sizes.

A wet magnetic separator is available either for treating ores containing highly magnetic material or for cleaning the magnetic media used in the heavy-medium separation machine. Dry processing can be done in a high-intensity magnetic separator of cross-belt design or by high-voltage separation in a laboratory-size unit, both machines being capable of continuous operation.

The preparation of ore for processing can be carried out by grinding and classification. Grinding can be carried out in batch or continuous mills, with either balls or rods, in open or closed circuit. A special hydraulic classifier developed in the laboratory can be used either for batch or continuous sizing and it can also be incorporated with a grinding unit when closed-circuit operation is required. In addition the equipment installed includes a conventional 3in cyclone unit for classification or desliming either by batch or continuous operation.

A rotary vacuum filter for dewatering solids during preparation and separation procedures can be used when required for filtration tests. Batch filters are employed for dewatering small samples and ovens are provided for drying the products made during the testing programmes.

A comprehensive selection of control equipment installed in the laboratory includes a "Rotap" sieve shaker and standard sieves, a "Haultain" superpanner and a "Franz" magnetic separator. These equipments, when used in conjunction with microscopic inspection, X-ray diffraction, and chemical analyses, provide valuable means for examining new ores and for assessing the results of treatment.

A section of the wet laboratory of the new mineral dressing laboratory

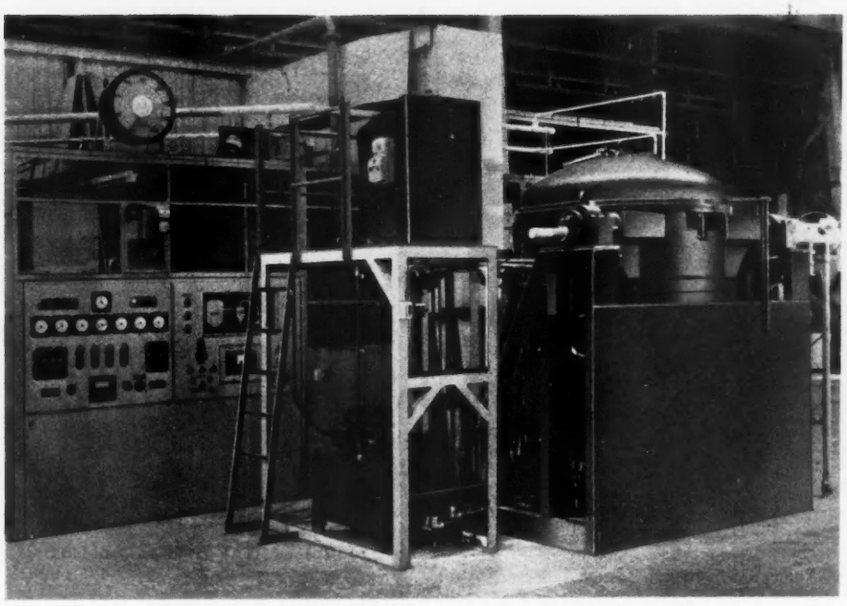
Naval Surveying

By Our Naval Correspondent

ELECTRONIC equipment capable of measuring long distances quickly with a high degree of accuracy is now being successfully used by the surveying branch of the Royal Navy. The Royal Navy was among the first to realise the applications in marine surveying of the Tellurometer set—as the equipment is called. It was developed by the Council of Scientific and Industrial Research in South Africa and uses the transit time of radio microwaves transmitted from a portable "master" and a portable "remote" station. Until the introduction of this instrument the surveyor had to measure a base line with steel tapes, or wire in catenary, with much attention to detail before he could build up his triangulation of fixed points relating to that base. Clearly the Tellurometer, with which distances of up to 80 miles or more have been measured along sight lines in a matter of twenty minutes or so, revolutionises the surveyor's task. Moreover, its introduction in hydrographic survey considerably reduces the time spent in the uneconomic early stages of a survey. During this period the surveyor is employed ashore fixing his triangulation stations before the ship and her boats can commence sounding. The first two sets of tellurometer were made available to survey ships last year and were quickly recognised as a boon by surveying officers, whose work has frequently been frustrated in the past by bad visibility. The equipment may indeed eventually obviate the need for horizontal angles to be taken when establishing a triangulation. The functioning of this device was outlined on page 538, April 5, 1957.

GOODWIN SANDS ON MOVE AGAIN

In his annual report the Hydrographer of the Navy also refers to the re-survey this year of the Goodwin Sands by the inshore survey craft "Echo." The sands have been surveyed at approximately ten-yearly intervals since 1844 and from time to time a distinct rotation of the bank in an anti-clockwise direction has been apparent from successive surveys. A comparison of the ten-year surveys carried out between 1916 and 1947 showed, however, that the movement of South Sand Head, the most southerly tip of the sands, had virtually ceased and no survey was carried out in 1957. It was the intention to re-survey after a fifteen year period in view of priority work elsewhere, and the restricted number of survey craft available. In September, 1958, the New Zealand Shipping Company liner "Rangitiki" reported grounding at a point half a mile south-east of the 1947 position of South Sand Head, where, according to the chart, she should have had plenty of water. H.M.S. "Echo" was at once sent to investigate and to carry out a survey. Despite a half-gale, she confirmed that the southern tip of the Goodwins was slightly more than half a mile south of the 1947 position. The South Goodwin buoy was moved by Trinity House to cover the extension of the bank. "This was a dramatic and unsuspected development in the brief space of eleven years and underlines the need for constant watchfulness and frequent re-survey of the many similar areas around our shores," states Admiral Collins.



Degassing and vacuum equipment for the refining of molten metals

Degassing and Vacuum Refining Furnace

WE illustrate a degassing and vacuum refining equipment for molten metals which has been introduced by Birlec-Efco (Melting), Ltd., Tyburn Road, Birmingham, 24. It is designed to meet the need for a relatively inexpensive equipment capable of giving close control over temperature and pressure. Turbulence of the metal in the vacuum vessel is induced electromagnetically and cycle times are stated to be reasonably short.

One of these equipments has recently been installed for vacuum refining of special alloys at the Birmingham works of Henry Wiggin and Co., Ltd. Basically it is a 15-cwt mains-frequency induction melting furnace housed in a tiltable vacuum tank. A water-cooled copper induction coil, which is supported by a magnetically shielded steel framework, forms the furnace proper. The insulating methods used take account of the difficulties of handling high voltages in vacuum. The vacuum tank, which houses the furnace, is mounted on trunnions and tilted by twin hydraulic cylinders. The tank movement produces an approximately lip-axis pouring effect from the furnace, and a retractable bridge over the top flange of the tank carries the metal stream. Hydraulic controls open and close the vacuum tank lid and pneumatic clamps lock the lid on to the tank. The furnace mouth carries a refractory cover (to conserve heat and reduce splashing losses) which has holes to correspond with a viewing port in the chamber lid. To allow for tilting, the vacuum pumping lines are connected to the tank concentrically with the tilting trunnion. The present installation includes a three-stage pump set which gives ample gas handling capacity over the whole range. Automatic controls maintain the correct pumping sequence and a dust trap protects the pump set from damage by fumes and metal splashes. Pirani and dial gauges monitor the furnace pressures. The whole equipment was designed for use by relatively unskilled labour with a minimum of technical supervision.

The present installation has a rating of 300kW and is arranged for connection to a low-tension three-phase supply. The output of 300kW gives this unit ample power for melting duty, though, for refining service only, a maximum rating of 200kW would suffice.

A typical vacuum refining cycle occupies about one hour. With the lid clamped in place, the chamber pressure is reduced to about 200–300 microns in about fifteen minutes. During refining, the power is reduced a value sufficient to ensure thorough stirring of the molten metal and to maintain the required temperature.

After vacuum treatment, air is readmitted to the furnace, the hydraulic gear raises the lid and the retractable spout is placed in position. The temperature of the metal is adjusted and checked by dip thermocouple and various other checks are made, after which the furnace is tilted, pouring the vacuum refined metal into a ladle for casting or teeming in the usual way.

We learn from the manufacturer that the results achieved so far on this installation have been satisfactory and that the high-temperature properties obtained on vacuum refined metals have exceeded forecasts based on laboratory work. A standard basic refractory lining is in use and gives satisfactory lives. It is rammed around a normal type former and presents no special problems.

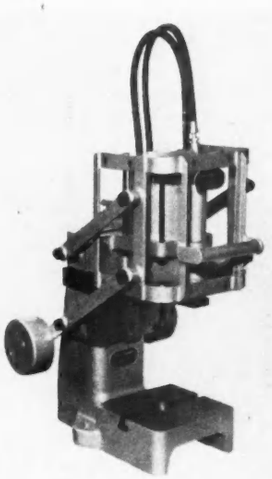
[Reply Card No. E5691.]

Small Pneumatic Press

THE small compressed air operated bench press shown in the illustration is made by A. A. Jones and Shipman, Ltd., Narborough Road South, Leicester. It has a stroke of 3in and with air at 100 lb per square inch will give a ram thrust of 1317 lb, or at 80 lb per square inch a thrust of 1053 lb. The head is adjustable in increments of 1in up the column of the machine and a maximum distance of $7\frac{7}{16}$in is available between the underside of the ram and the table.

A counterbalanced guard in front of the head is interlocked so that it must completely screen the work table before the ram descends. The speeds of ram ascent and descent are controlled by the setting of two throttle valves in the main valve block of the press. To facilitate the fitting of tools the ram is bored with a $\frac{1}{4}$in diameter hole and a tee-slot is cut across the width of the 7in by $6\frac{1}{2}$in table.

[Reply Card No. E5692]



Pneumatic press with 3in stroke ram and 7in by 6½in table

Reducing Valves

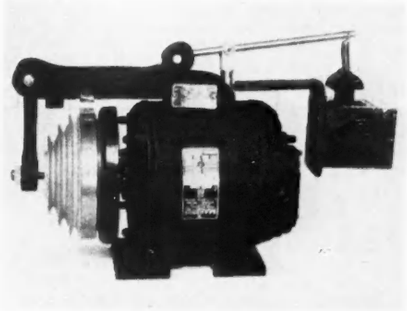
A NEW modular system of pneumatic reducing valve design has been introduced by the Hymatic Engineering Company, Ltd., Redditch, Worcs, to overcome the high costs involved in producing prototype valves for aircraft manufacturers. Under this system the firm's design staff analyses a specification and selects the appropriate valve parts from standard interchangeable components. It is stated that the number of different variants which can be produced in this way is over 5000, and further variations can be made available by changing springs and settings. The component parts used suit valves for either hot or cold air and referenced to either an absolute or an ambient datum.

The range of valves available covers inlet pressures up to 4000 lb per square inch and designs have been prepared for components up to 6000 lb per square inch supply pressures. In general, the valves are intended for flows up to 30 cubic feet per minute—depending upon the supply pressure and outlet pressure tolerances specified. At present outlet pressures up to 120 lb per square inch are covered, but it is proposed eventually to cover outlet pressures up to 2000 lb per square inch. A standard inlet connection of $\frac{1}{4}$in is used on the valves, and $\frac{1}{4}$in, $\frac{3}{8}$in or $\frac{1}{2}$in B.S.P. outlet connections can be supplied in accordance with requirements.

[Reply Card No. E5693]

Clutch-Motor Drive

THE "Mardrive" clutch-motor, which has been made for a number of years by the Marine Engineering Company (Stockport), Ltd., Bulkeley Street, Stockport, is now available with means of automatic or semi-automatic control. In these drives, which are provided for up to 3 h.p., a heavy flywheel is mounted on the continuously running motor shaft. A clutch engages with the face of the flywheel as and when drive is required to a pulley, such as is shown in the illustration ;



Clutch-motor drive fitted with solenoid actuation for remote control

when the clutch is released a brake is immediately applied on a rim at the back of the pulley.

For automatic control purposes, when compressed air is available, a pneumatic cylinder controlled by a trip valve or similar device is used to operate the clutch. Alternatively there can be used a solenoid controlled by a micro or time switch to engage and disengage the drive. In the semi-automatic control the clutch is engaged by a hand or foot control to give a gradual acceleration of the drive in coil winding and similar machines. When the full driving speed is reached the clutch is locked in by a solenoid operated spring latch. When it is required to disengage the clutch the solenoid trips the latch and the brake is immediately applied to stop the machine.

[Reply Card No. E5694]

Universal Scintillation Counter

A NEW bench-standing universal scintillation counter, Type N664, is announced by Ekco Electronics, Ltd., Southend-on-Sea, Essex. Beta emitters, including tritium and carbon 14, are counted in a liquid phosphor, while for gamma emitters a thallium-activated sodium iodide crystal is employed.

For liquid counting, the lead-shielded well is fitted with a shutter/sample holder assembly, enabling the sample pot to be loaded into the instrument while the photo-multiplier is covered by an interlocked light-tight shutter. The sample pot is automatically lowered directly on to the photo-multiplier face when the large lead cover is closed, and at the same time the shutter interlock is released. The sample chamber is shielded in all directions by 2·5cm of lead.

For gamma counting, the sample may be prepared in a test-tube, a polythene annular container or a 50 ml. flat beaker, appropriate

Scintillation counter opened to show sample holder ready for lowering on to photo-multiplier by closing lead cover

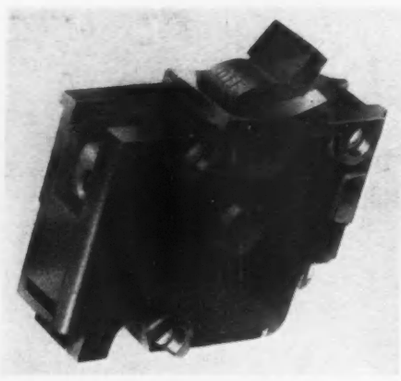
crystals being available for each. The shutter assembly used for liquid counting is replaced by a top-plate assembly on which the crystals are mounted. Lifting the counterbalanced lead lid exposes the crystal for sample changing.

A high-gain amplifier is included in the unit which is contained in a strong steel case with carrying handles.

[Reply Card No. E5701]

Moulded-Case Circuit Breakers

AN exhibition of moulded-case circuit breakers with ratings from 5A upwards has been held in London by E.C.C. (Moulded Breakers), Ltd., Fordhouse Road Works, Wolverhampton. Units from 5A to 60A are known as the "Stab-Lok" range and are designed for installation in flush- or surface-mounting moulded-case distribution boards with backplates and busbars having hook projections and slots by which the breakers are held in place and connected to the incoming supply by self-locking four-way stabs. A single-screw solderless terminal is located on the load side of the contacts. In the 5A "Stab-Lok" circuit breaker the bimetal for overload tripping is indirectly heated, and there is a separate coil-energised magnetic trip for instantaneous operation at ten times rated current. Other sizes have current-carrying bimetals and all are compensated for ambient temperature. On tripping, the handle snaps to "off" and the latch is reset automatically on



Circuit breaker with self-locking stab connector to busbars and moulded case shaped to locate with supports in distribution board

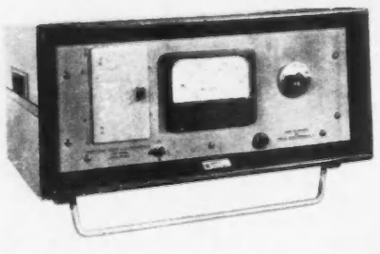
reclosing. Various sizes and arrangements of distribution boards incorporating these circuit breakers were shown, ranging from a small consumer's unit to large assemblies suitable for colleges, office blocks, hotels and other public buildings. The breakers are of uniform size irrespective of rating.

Moulded-case construction is also used in the larger "NJ" (two-pole and three-pole) and "N.E.F." (single- two- and three-pole) ranges, examples of which were displayed. The "NJ" breaker shown was a three-pole 10MVA unit with individually-adjustable overloads in each phase, and the "N.E.F." series was represented by a triple-pole unit for 440V a.c. with a tested breaking capacity of 9000A. Both types of breaker can be supplied with a lockable rotary handle which returns to a "trip" position on tripping so that the unit affected can be identified, and may then be locked "off" by the electrician investigating the fault. The alternative "dolly" form of handle also returns to a midway position on tripping and must be returned to "off" before the breaker can be reclosed, so inadvertent closing on to a fault is impracticable. The breakers are suitable for panel or individual mounting (for which enclosures are available) or for incorporation in other control gear, examples shown being an 80kW alternator control panel and a direct-on starter using a moulded-case circuit breaker as an interlocked isolating switch.

[Reply Card No. E5702]

Vibrating Reed Electrometer

FOR measurement of very small direct currents and voltages with high zero stability, a new vibrating reed electrometer, Type N616, has been introduced by Ekco Electronics, Ltd., Southend-on-Sea, Essex. The instrument uses the principle of the company's earlier "N572" electrometer in that an a.c. voltage is developed by applying the d.c. to a capacitor of which one plate is formed by a reed maintained in vibration by a valve circuit. Since the instantaneous voltage across the capacitor is proportional to the reciprocal of the instantaneous capacitance,



Stable a.c. amplifier and indicator for measurement of small d.c. voltages after conversion to a.c. by vibratory capacitor

an a.c. voltage is developed for amplification by a stable a.c. amplifier and subsequent rectification.

In the present instrument the rectified output is measured on a 5in panel meter calibrated to show the d.c. voltage at the input. Seven ranges are provided, namely, 3mV, 10mV, 30mV, 100mV, 300mV and 1V and 3V. For voltage measurements the accuracy is of the order of 5 per cent and current measurements may be made to the same accuracy provided the total value of the input resistance is known and a calibration control is adjusted accordingly. Three switched input resistors of 10^8, 10^{10} and 10^{20} ohms are provided. The electrometer unit may be removed from the indicator unit and attached to an ionisation chamber for measurement of ionisation currents. Power supplies are 110–120V or 200–250V, 50 c/s or 60 c/s, and the power consumption 60W. An external 100mV recorder can be operated and outputs of 215V at 5mA, 105V at 2mA and 6·3V at 0·3A are available for other equipment.

[Reply Card No. E5703]

All-Insulated Portable Transformers

A RANGE of transformers up to 1500VA introduced by the Sturdy Electric Company, Ltd., Sturdy Works, Hamsterley Colliery, Newcastle upon Tyne, for operating low-voltage portable electric tools and handlamps is enclosed in "Fibreglass" cases of high impact strength. This material is proof against corrosion and requires no painting for preservative purposes. The design of the case has been studied to eliminate exposed metal components such as screws which might become at high potential, and the cases are therefore filled with sufficient bitumastic compound to cover the core and windings, thus securing the transformer inside the case and providing a seal against the atmosphere. Nylon screws secure the lid, and the primary cable gland is also of nylon. The carrying handle, as shown, forms part of a webbing

Low-voltage transformer in "Fibreglass" case with webbing harness and carrying handle

harness passing around the sides and base of the case. A wall-mounting bracket can be supplied for permanent installations in fixed locations.

Moulded rubber sockets and plugs available for the 5A and 15A sizes are keyed to prevent insertion of a low-voltage plug into a higher-voltage socket. The transformers have a centre-tapped secondary and an earthed metal screen between primary and secondary windings. Provision is made for earthing the centre point. They are supplied for all the usual mains voltages with output voltages of 110V, 50V or 25V.

[Reply Card No. E5704]

Industrial and Labour Notes

Coal Industry's Prospects

On Thursday of last week, the National Coal Board met representatives of the National Union of Mineworkers to discuss the proposals set out in the *Revised Plan for Coal* (THE ENGINEER, October 23). The Board outlined measures which it considers must be taken to deal with the coal industry's present situation.

These measures include a further reduction in opencast coal production next year of 4,000,000 tons and the closure of six pits on economic grounds. These six pits are additional to the twenty-four which are to be closed because their reserves will be exhausted and the sixteen pits which are to be merged with others or from which men are to be transferred to neighbouring pits. Some reduction of output from other pits by single-shift working and other means is also to be undertaken. The Board again assured the union representatives, however, that everything possible would be done to keep long-term redundancy to the minimum. There are now to be further discussions between the Board and the union at coalfield level.

The latest information as to coal production, consumption and stocks was given on Monday, in a Parliamentary reply, by the Minister of Power, Mr. Wood. He said that total production this year might be 207,000,000 tons, compared with 216,000,000 tons last year, and that this year's consumption, including exports, might be 195,000,000 tons, against an estimate of 200,000,000 tons and an actual consumption last year of 208,000,000 tons. Undistributed coal stocks on October 17, the Minister added, totalled 35,000,000 tons, compared with the estimate made some months ago that they would be 23,000,000 tons at the end of this year.

Shipbuilding Productivity Team

Recently a shipbuilding productivity team sponsored by the British Productivity Council visited a number of Swedish shipyards to study shipbuilding techniques, such as materials handling, plate preparation, prefabrication ; also the layout of the yards and labour relations. A full report has yet to be prepared and the various findings analysed. However, the team, on its return, was able to confirm that there is in practice only one trade union for negotiating purposes and that in the steel trades there is great flexibility so that a worker can perform a number of jobs without being concerned with any problems of demarcation. In planning work there is a wide degree of consultation right down to foreman level, and another important point mentioned by the team was that " wildcat " strikes are illegal, while, in addition, provision is made for claiming compensation from either the union or the employer for any loss caused by an industrial dispute.

Industrial Relations

On Monday, the Minister of Labour, Mr. Edward Heath, was asked by Mr. Darling if he would ask the employers' side of his National Joint Advisory Council to inquire into the attitude of employers and their trade associations to modern wage systems and to consultation with trade unions on all industrial questions. Mr. Darling suggested that as the Trades Union Congress was looking into any faults and weaknesses which there might be in trade union methods and organisation, employers might set up a similar inquiry to remedy their faults and weaknesses.

In his reply, the Minister said he had no doubt there were things which could be made better on all sides of industry. Industrial relations were a problem of human relations and as soon as human relations were involved the element of human weakness entered. It was the practice that things were not put to one side alone of the National Joint Advisory Council. The initiative for the inquiry by the T.U.C. had been taken by the T.U.C. itself ; it had not been taken as part of, or one side of, the National Joint Advisory Council. The initiative for setting up any such inquiry as that suggested by Mr. Darling, the Minister added, must rest with the employing side of industry.

The Employers' Function

The British Employers' Confederation comments, in a recent bulletin, that a fairly common complaint by responsible trade union leaders is not that employers are too tough in their relations with their workpeople but that they are sometimes too weak. Examples showing that there is some justice in this complaint as regards industry, both public and private, will occur to everyone. Local pressure, the Confederation says, has often been allowed to interfere with agreed plans to close an uneconomic pit, to introduce a new machine to perform a loading or unloading task at a dock, or even to transfer a single man to a new job. These examples show that many of the difficulties which arise are due to the fear of redundancy, frequently where there is no real basis for such fear.

It is often said, the Confederation continues, that wage increases make employers adopt more efficient methods. Wage increases certainly must make employers try to see how they can get at least the same volume of production from the same wage cost, that is, by employing fewer men on the particular job. The advocates of higher wages, the Confederation suggests, can hardly complain about that. If a change in the method of working is involved, no wise employer, the Confederation asserts, would seek to introduce such a change without at least attempting to get it accepted by his workpeople. That is where joint consultation can be usefully employed. But the decision whether it is to be introduced or not must, after a review of all the circumstances, rest with the employer. A wise assessment of all the factors, followed by a firm decision, is, the Confederation claims, the employer's true function.

British Trade Fairs Overseas

The Federation of British Industries says that arrangements have recently been concluded to broaden the base of British Overseas Fairs, Ltd., in order to equip it for the increasingly important task of organising British trade fairs in overseas countries. The British Exhibition in New York in June, 1960, will be the biggest and most important display of British industry's consumer and engineering products ever to be shown overseas. Further projects for later years are under consideration in other parts of the world. In view of this constantly expanding role in the service of British exports, some new arrangements, which have been approved by the Board of Trade, are announced.

In order to provide for harmonious working between the national organisations concerned with trade and industry in all matters affecting British trade fairs overseas, the presidents of the Association of British Chambers of Commerce and of the National Union of Manufacturers, Mr. Frank Bower and Mr. M. D. Oliphant respectively, have been elected to the Board of British Overseas Fairs, Ltd. (B.O.F.). The directors are now, therefore, as follows : Sir Norman Kipping (chairman), Mr. Frank Bower, Mr. W. P. N. Edwards (managing director), Sir Leslie Gamage, Lieut.-Col. Lord Dudley Gordon, Mr. M. D. Oliphant and Mr. P. F. D. Tennant. The Grand Council of the Federation of British Industries will, as before, determine the programmes of British trade fairs overseas, but it will in future be advised by a new Export Promotion Policy Committee of which Sir Leslie Gamage is the chairman. Representatives of the Association of British Chambers of Commerce and the National Union of Manufacturers will attend the meetings of this committee. The Board of Trade and Foreign Office will be consulted, as in the past, before the programmes are finalised.

The Joint Iron Council

The annual general meeting of the Joint Iron Council was held in London on Tuesday, when the executive committee's report for the year 1958–59 was adopted. The report comments on the fact that it " spans the period of maximum effect of the policy of credit squeeze and the beginning of expansion resulting from new policies adopted by the Government in the autumn of 1958." Delays in effectiveness of policy changes are, of course, especially marked in the case of investment expenditure and this kind of expenditure is particularly significant to ironfounders whose most important customers are often the makers of capital equipment. While investment spending by the Government, the nationalised industries and the local authorities has risen during the first half of 1959, there is little sign yet, the report comments, of a rise in private industry's capital investment. The report notes that the total output of iron castings for the twelve months ended June last was 9 per cent lower than in the preceding year. But the reduction is attributed mainly to weak trading in the first three quarters of the year. The final quarter's output virtually equalled that of a year earlier and was 6 per cent above that of the preceding quarter.

On Tuesday evening, the Joint Iron Council's annual dinner was held at the Dorchester Hotel, London, under the chairmanship of the president, Mr. N. P. Newman, The principal guest was the President of the Board of Trade, Mr. Reginald Maudling. Proposing a toast to " the Iron Industry," Mr. Maudling said that the Board of Trade was deeply concerned with the expansion of world trade. Indirectly, he added, the iron industry, by providing so many essential components, made a considerable contribution to the export drive. The Government, Mr. Maudling commented, was keenly aware of the fundamental importance of having more freedom in world trade. Keeping in mind this country's close ties with the Commonwealth and with its friends in Europe, Mr. Maudling expressed his conviction that the country was well able to " carve out " a proper share of the world's trade.

Development of the Sulzer Marine Diesel Engine

FOR about sixty years the firm, Sulzer Brothers, has been actively engaged in making diesel engines and it is interesting to note that the first directly reversible marine diesel engine, a 90 h.p., four-cylinder, two-stroke engine, was actually built, in 1905, in the works at Winterthur (Fig. 1). From this modest beginning the diesel engine has gone step by step through various stages of development and has firmly established its present-day position as the principal prime mover in the world of shipping. There can be no doubt that the Winterthur works of Sulzer Brothers, Ltd., in spite of their position in the heart of Europe and hundreds of miles away from the nearest seaport, have greatly contributed to this success; between 1907 and 1959 they and their numerous licensees all over the world have equipped more than 1200 vessels with two-stroke marine engines totalling over 7,000,000 s.h.p. (ships of less than 2000 tons deadweight not included).

The manufacturing programme of Sulzer Brothers comprises a wide range of two-stroke and four-stroke engines; the latter, mainly used for stationary installations and for marine auxiliaries, cover a range of 120 h.p. to 1200 h.p. at speeds of 500 and 600 r.p.m. In addition to these engines a range of four-stroke engines specially designed for traction work is also being built. The cylinder sizes vary between 220mm and 280mm in diameter with corresponding outputs between 300 h.p. normally aspirated, and 2400 h.p. with supercharging. A further range, at present still in the development stage, will be built as "V"-engines having eight, twelve, or sixteen cylinders and covering a power range from 1500 h.p. to 3500 h.p.

Two-stroke engines used for small and medium output are of the single-acting trunk piston design. They all employ the cross-scavenging system and have individual scavenging pumps for each cylinder, arranged at the side of the engine and operated from the connecting-rod by a rocking lever. This arrangement has the advantage that it reduces the length of the engine and ensures that each cylinder receives the same amount of air at a constant pressure. Moreover, the short crankshaft and symmetry resulting from the rocker drive of the individual pumps considerably improves the vibration characteristics and reduces balancing problems.

Engines of this design have been, and are still being built, with cylinders ranging from 240mm to 560mm bore, with corresponding outputs of 300 h.p. to approximately 4000 h.p., and up to 5000 h.p. in their supercharged version. The smaller engines are used for river and coastal work, and the larger ones for small cargo ships. A basically similar line of engines with shorter stroke and, consequently, higher speeds are being built with cylinder diameters up to 510mm, covering a power range of 600 h.p. to 5000 h.p. and up to 6250 h.p. in their supercharged version.

Turning now to the larger marine units, it is obvious that for cylinder diameters of more than 550mm the trunk piston design is not a very satisfactory proposition. Faced with the task of providing large marine engines suitable for heavy oil operation, Sulzer Brothers in 1943 introduced the "SD," similar in its basic conception to the previously mentioned trunk piston engines, but fitted with "A"-frames, crossheads and stuffing-boxes. Over the last fifteen years, more than 3800 cylinder units of this type, totalling about 2,600,000 h.p., have been made by the Winterthur firm and their licensees. With a cylinder bore of 600mm or 720mm they were built in various sizes from five up to twelve cylinders, covering a power range from 2500 h.p. to 8500 h.p. normally aspirated, and up to 10,800 h.p. with supercharging.

Fig. 2 shows the cross section of the supercharged version engine, type "SAD 72," with 720mm cylinder bore. The engine has a cast-iron bedplate and "A"-frames, the side-mounted scavenging pumps being driven by rocking levers actuated from the crosshead. Two rows of scavenge ports are provided, the upper one of which is fitted with a series of non-return valves which allow after-charging of the cylinder once the exhaust ports have been covered by the rising piston.

There is a common housing for the fuel pumps on the scavenge-pump side of the engine near crankshaft level, the camshaft being driven through a short spur gear train. Instead of providing the engine with a piston-rod, the piston skirt is extended down to the crosshead and the crankcase is separated from the cylinder by a stuffing-box working on the outside diameter of the piston.

Although the "SD" design was originally designed as a normally aspirated engine, about 20 per cent of all engines of this type made in the last decade were actually equipped with turbo charging. The system used for this application is the Curtis arrangement which is particularly suitable for the modification of existing engines. In this system, which has also been adopted for converting the trunk-piston designs to supercharging, the scavenging pumps are retained and work as second stages in series with an exhaust gas-turbine-driven blower; an air-cooler, fed with sea-water, is fitted between the two compression stages. Fig. 2 clearly shows the various components of the Curtis turbo-charging arrangement which is being used here. The exhaust-gas turbine-driven blower (1) delivers the scavenging air by way of an air-cooler to the receiver (2) from which it is distributed to the engine-driven scavenging pumps (3). From the latter the air passes through a common air receiver into the cylinders (4). The pulsations of the discharged exhaust gases are efficiently damped in the wide, heat-insulated manifold (5), so that the gas turbine operates at constant intake pressure. The temperature of the gases after their discharge from the gas turbine is still high enough to be utilised in a waste-heat boiler.

With the Curtis charging arrangement, the engine behaviour at all loads, including starting and manœuvring, is similar to that of normally aspirated engines, and so is the fuel consumption. The power increase by turbo-charging in case of the "SD" engine amounts to about

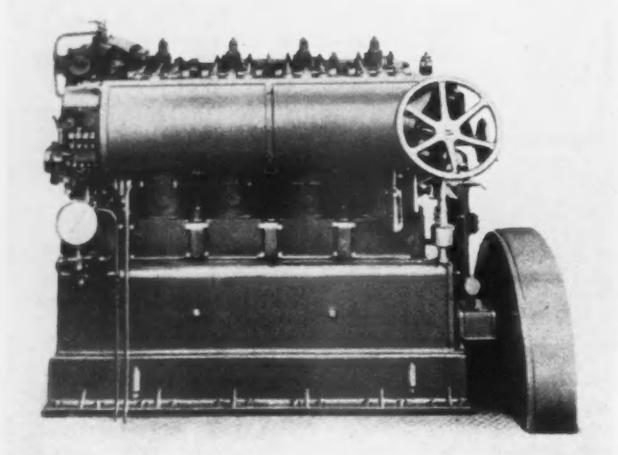
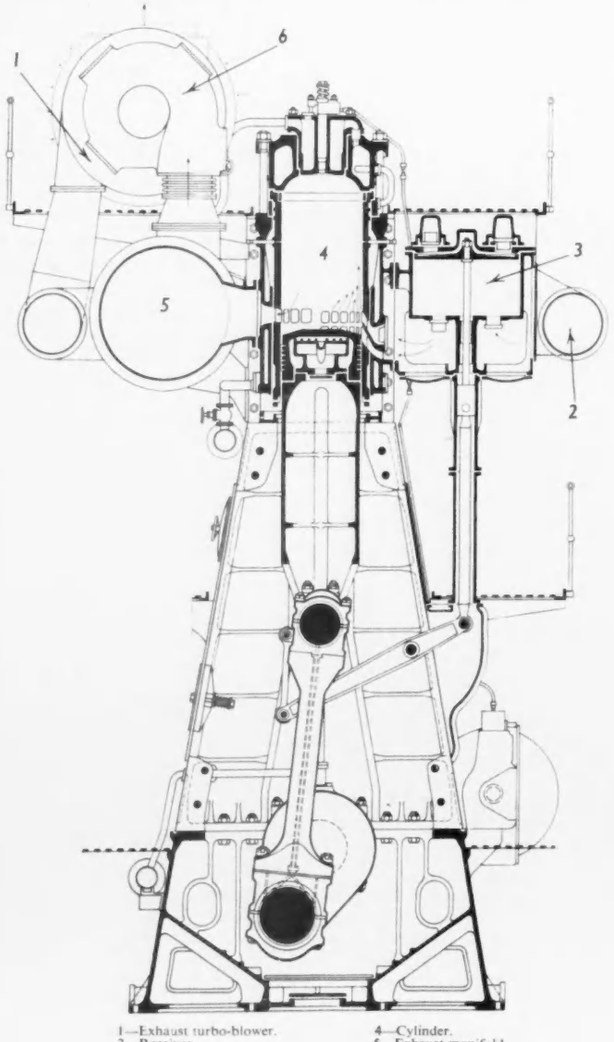


Fig. 1—90 h.p., four-cylinder, reversible, two-stroke engine built in 1905



1—Exhaust turbo-blower.
2—Receiver.
3—Scavenge pump.
4—Cylinder.
5—Exhaust manifold.
6—Exhaust gas turbine.

Fig. 2—"SAD 72" turbo charged engine of 720mm bore and 1250mm stroke

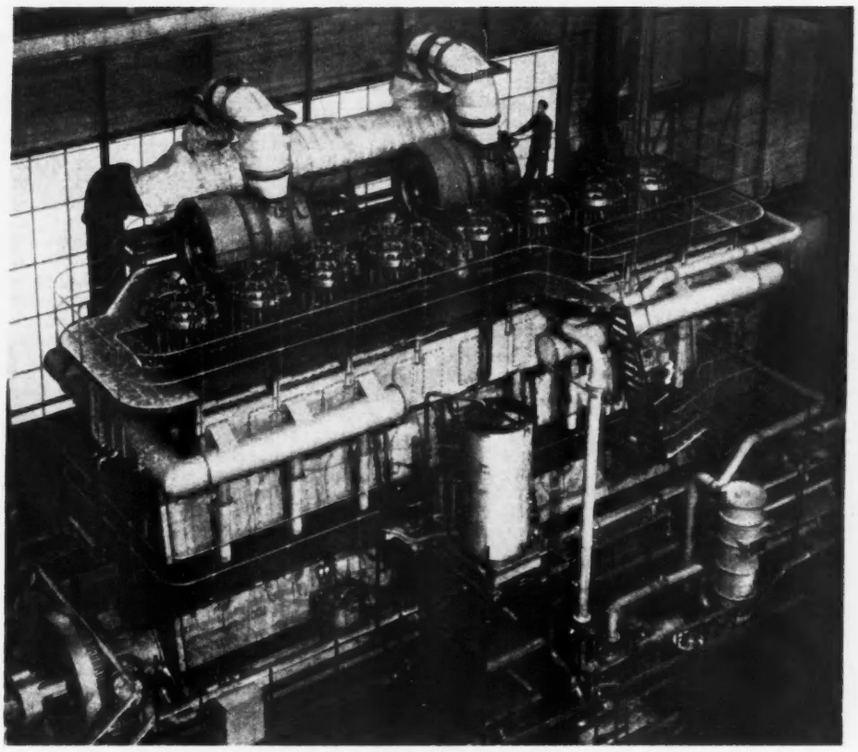
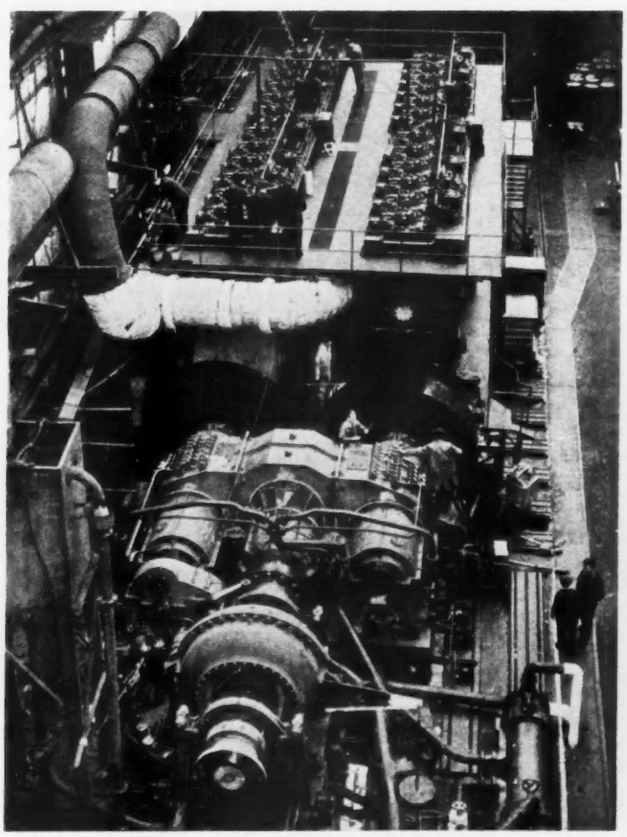


Fig. 3—Test bed view of eight-cylinder "SAD" engine

28 per cent. A disadvantage of the Curtis system, compared with other turbo-charging arrangements, is that the power requirement of the scavenging pumps is only slightly reduced, especially when the engine is lightly loaded; for this reason the size of these pumps is only a little below that required for a non-supercharged engine, a factor which accounts for the almost identical fuel consumption of both designs.

Our illustration (Fig. 3) shows a supercharged eight-cylinder "SAD" engine on the test-bed; there are two turbo-chargers on top of the wide exhaust manifold, and of the two delivery pipes each leads to a group of four scavenging pumps. At the flywheel end the engine has two air-coolers which are built in the air delivery ducting, one of which is also visible in the illustration. This eight-cylinder engine has a bore of 720mm and a stroke of 1250mm; with a brake mean effective pressure of 4·95 kg per square centimetre (70·4 lb per square inch) the engine output is 7200 h.p. at 125 r.p.m., compared with 5500 h.p. of the equivalent non-supercharged engine. The capacity of the scavenging pumps of the supercharged eight-cylinder engine has been reduced: by dispensing with the complete double-acting pump of cylinder No. 5 and, further, by running that of cylinder No. 1 in single action, the total reduction in the delivery volume of the engine-driven pumps amounts to about 19 per cent.



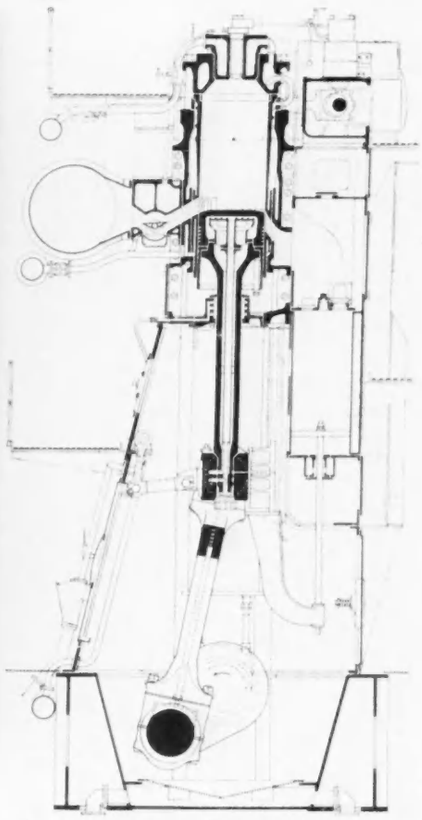
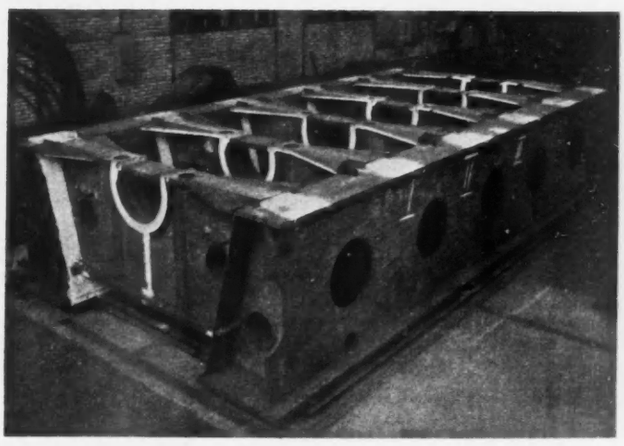


Fig. 6—Normally aspirated version of "RSD 76" engine. The trunk piston has been replaced by a short piston and piston-rod, an oscillating butterfly valve being used to close the exhaust at top dead centre, preventing air loss across the space under the piston

The great advantage of the diesel engine over the steam turbine is its excellent thermal efficiency. In many cases, however, where very large outputs are required, turbines are installed because of the difficulty of supplying sufficient power from one diesel engine for driving one single propeller shaft. There is a growing demand for engines of moderate size which allow a greater output to be directly transmitted to the propeller shaft. The raising of the brake



Figs. 4 and 5—(Left) Two "RSD 58" twelve-cylinder engines arranged to drive the output shaft through twin reduction gearing. The illustration shows the engines on the test bed. (Right) Fabricated bedplate, showing box construction of longitudinal and transverse walls

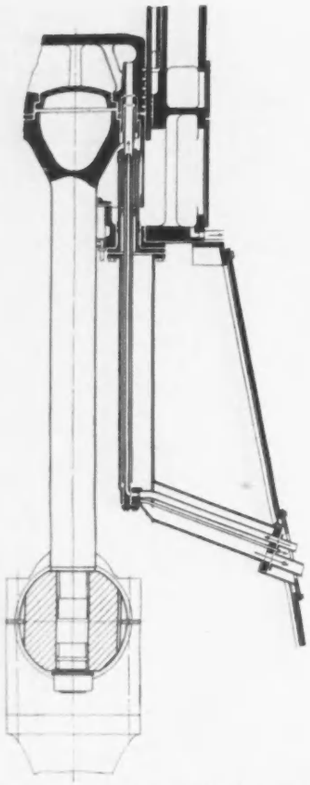


Fig. 7—Arrangement of telescopic inlet and outlet pipes used for cooling water where the pistons are water cooled

mean effective pressure by supercharging is one way of solving this problem, another is the use of double-acting engines. However, the latter do not usually find favour with the operators and the sea-going personnel, because of their more complicated design and the greater work entailed in their maintenance and overhaul. Statistics show that to-day a much smaller percentage of double-acting engines is produced than in recent years.

If more complicated schemes, such as multiple diesel-electric drives or free-piston gas generator installations, are disregarded this leaves as a practical choice for high-output machinery either the largest feasible long-stroke engine for direct propeller drive or a number of smaller and faster engines, connected by couplings and gearing to a common shaft. To meet these requirements Sulzer Brothers in 1953 introduced two new engines, both of similar design, having cylinder bores of 760mm and 580mm respectively. The larger of these two engines, the model "RSD 76,"* with a stroke of 1550mm, develops 1000 h.p. at 119 r.p.m., an output which can be increased by as much as 30 or 40 per cent by supercharging. Due to its long stroke, the engine builds somewhat high, which for cargo ships and tankers is of no particular importance, but may be a decided drawback for passenger vessels. For such a ship two or more engines of the smaller design, having a stroke of 760mm and developing 500 h.p. per cylinder (or 700 h.p. in the supercharged version) at 230 r.p.m., coupled to a geared drive, may be of advantage. Fig. 4 shows such an installation on the test-bed, comprising two normally-aspirated twelve-cylinder engines of the type "RSD 58."

In designing these engines, the three major aspects which had to be taken into consideration were the use of heavy oil, the possibility of providing engines of a fabricated and welded design, and of making allowances for the increase of power afforded by supercharging.

The difference between the older marine engine models "SD" and "SAD" of 720mm bore and the new 760mm bore engine is apparent from Fig. 6, showing the normally-aspirated version of the type "RSD 76." The most important details are the replacement of the long piston, with its extension directly connected with the crosshead, by one of considerably reduced length, and a piston-rod linked in the orthodox way to a single-guided crosshead. The laterally-arranged, single-acting scavenging pumps are driven by arms bolted directly to the crossheads of the corresponding cylinders. This modification allows the use of a stuffing-box having the diameter of the piston-rod, instead of that of the piston skirt of the older type, and provides a better method of partition between cylinder and crankcase. It more effectively prevents combustion products containing sulphuric acid and abrasive matter from entering the crankcase, thus greatly improving the suitability of the engine for heavy oil operation.

In cross-scavenging engines, however, the piston at top dead centre has to cover both the inlet and the exhaust ports in order to prevent scavenge air being carried under the piston and out into the exhaust manifold. As the short piston does not satisfy these conditions, some method of preventing the loss of scavenging air has to be provided. To achieve this an oscillating valve, operated by means of rods and levers from an eccentric on the fuel-pump shaft, closes the exhaust passage at the end of the scavenging period and does not open until the piston on its downstroke has covered the ports again. This arrangement has the additional advantage that it allows the aftercharging of the cylinder up to the pressure of the air in the air receiver without the provision of a second row of inlet ports with non-return valves. Further, the asymmetric port timing allows a direct utilisation of the exhaust pulses in the supercharger, by supplying a larger proportion of the gas energy to the turbine; it has a favourable influence on the efficiency of the turbo-charger in all cases where comparatively low super-charging pressures are required.

In order to meet the wishes of Messrs. Sulzer's licensees and of several shipyards, the "RSD" engine was so designed that the major parts could be constructed either by welding or by using cast iron. The welded construction employs bed-plates and "A"-frames fabricated from steel plate; instead of ribbed walls, common in cast constructions, box-type sections are used as basic elements, giving utmost rigidity with a minimum of welding seams. A prefabricated bed-plate is shown in Fig. 5 which in particular illustrates the construction of the transverse members which incorporate the double-wall support of the rolled-steel bearing saddle.

The gas pressures are transmitted from the top of the cast-iron cylinder casing directly to the transverse bearing member of the bed-plate by tie rods. In order to keep the bending stresses in the bed-plate at a minimum, the tie rods are arranged as close to the centre line as possible. This arrangement leaves no room for locating the caps of the main bearings by means of the usual studs; the bearing caps are kept in position by jack bolts interposed between the caps and the centre section of the "A"-frame. Pretensioning of the tie rods places the cylinder casings, the "A"-frames and the bed-plate under compression so that they are not subjected to tensile stress.

The pistons are either oil cooled or, in cases of high thermal loading, water cooled. If oil cooling is employed, the oil is carried through linked swinging pipes to the crosshead; from there it continues through the hollow piston-rod to the piston, cooling the inner surface of the piston crown, and is returned downwards to the crosshead through a pipe placed in the centre of the piston-rod. The lubricating oil for the big-end bearing is branched off at the crosshead and fed through the bored-out connecting-rod; thus, no oil ways have to be drilled in the crankshaft. In case of water cooling, the cooling medium is led through a telescopic pipe to the piston head and is drained by way of another telescopic pipe into a waterbox (Fig. 7). The latter is bolted to the bottom of the partition separating the cylinder and the crankcase; a sleeve in the side plate forms a watertight seal between the water pipes and the interior of the

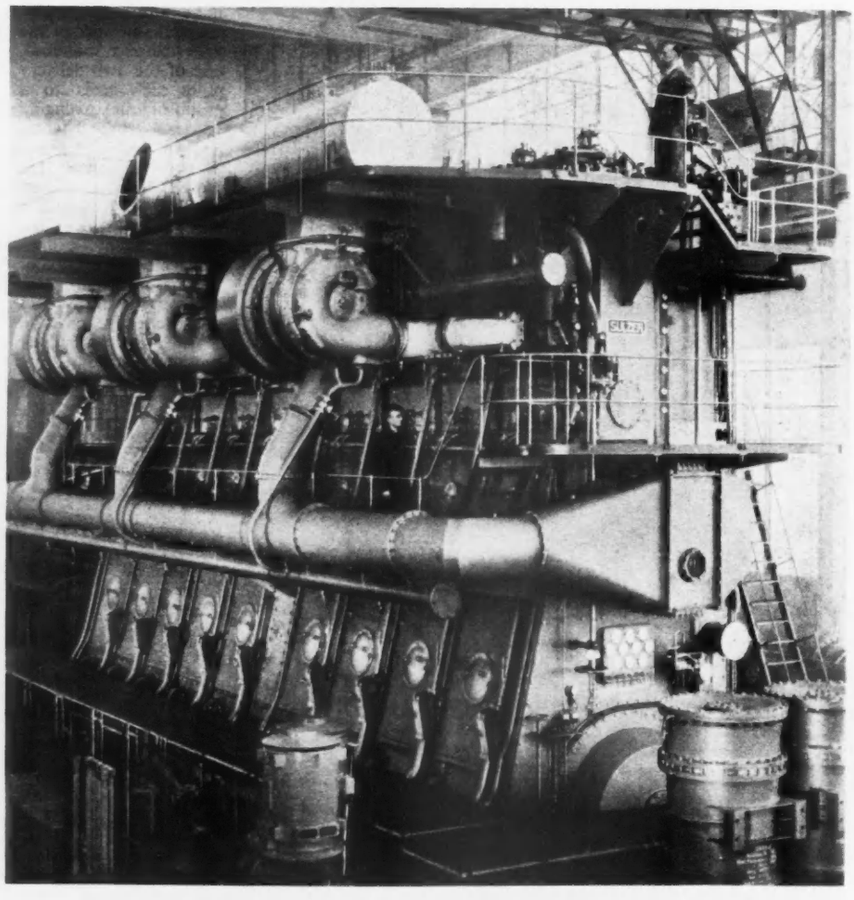


Fig. 8—A nine-cylinder "RSAD 76" engine on the test bed

* THE ENGINEER, November 12, 1954, page 663.

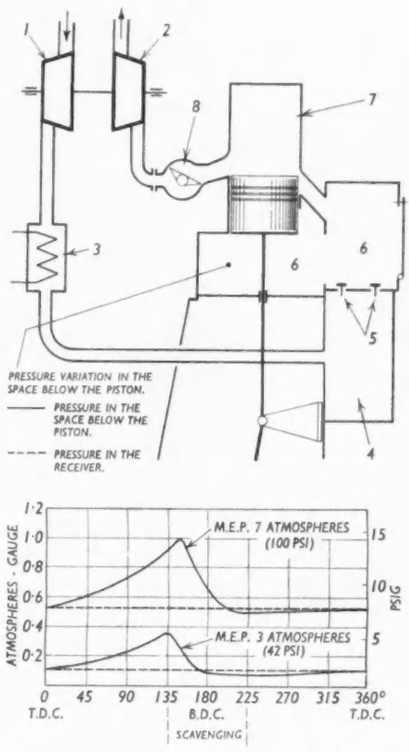


Fig. 9—Layout of supercharging (pulse) system and typical pressure-time curves

crankcase, thus preventing any contamination of the lubrication oil by leaking water.

The two sizes of 580mm and 760mm bore of the engine model " RSD " can be and, in fact, have been built as normally aspirated engines ; however, they lend themselves eminently to supercharging because of the following reasons :

The short piston, and the piston-rod design, in conjunction with the partition between cylinder and crankcase, allows the bottom part of the cylinder to be utilised as a single-acting scavenging pump. Secondly, the controlled discharge of the exhaust gases not only causes less scavenging air to be required, but also favours the application of the pulse-charging system for the exhaust turbine, which gives a considerably higher efficiency than the constant-pressure system. The combined effect of these two factors permits dispensing with the separate engine-driven scavenging pump altogether, and obtaining perfect operation and manœuvrability on the turbo-blower alone, without any additional means for the scavenging supply.

As shown diagrammatically in Fig. 9, there is a separate scavenge air chamber provided for each cylinder, which, together with the air space below the piston, forms a buffer chamber. This is connected, through non-return valves of low flow resistance, with the common air receiver, which is supplied with air from the turbo-charger. The air contained in the buffer chamber and in the cylinder space between the bottom of the piston and the partition is compressed during the downstroke of the piston. The pressure obtained exceeds that of the gas pressure existing in the cylinder at the time of the opening of the scavenge ports. This pressure difference causes the first phase of the scavenging to begin with a strong impulse, counteracting the blow-back of the exhaust gases. Towards the end of the scavenging period the pressure in the buffer chamber drops below that of the air receiver ; air from the latter flows through the non-return valves into the buffer chamber, and the last phase of the scavenging process takes place at the pressure determined by the turbo-blower. The pumping action of the piston is quite sufficient to scavenge and charge the cylinders when the engine is being started up, i.e. before the turbo-charger becomes operative. In fact, even if all the turbo-chargers should be out of action, a ship could still be run at approximately 75 per cent of its normal speed.

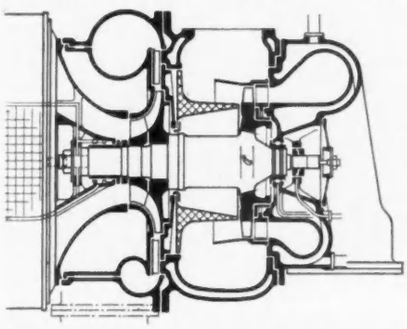


Fig. 10—Sectional view of exhaust turbo-charger

The adoption of the turbo-charging system described above in the " RSAD " engine necessitates only minor alterations of the normally aspirated engine. As the scavenging pumps and their drive gear are not required any more, the space now available can be utilised to accommodate an air receiver of increased capacity (see THE ENGINEER, August 14, 1959, page 73). The exhaust ports have to be extended in height as the expansion is slower owing to the back pressure of the turbine ; this naturally reduces to some extent the energy transmitted to the piston, but it supplies a larger proportion of the gas energy to the turbine. The wide, heat-insulated exhaust manifold, characteristic of the constant-pressure turbo-charger, has been replaced by short, small-diameter passages leading straight from the cylinder to the intake of the pulse-system turbine; as a rule not more than three exhaust pipes are joined to each individual turbo-charger.

Fig. 10 shows a section through the turbo-charger. The design, which was specially developed for Sulzer marine engines, has a delivery capacity capable of being extended from 7·5 kg to 12 kg per second (about 16 lb to 28 lb per second) at a pressure ratio of the compressor corresponding to full-load conditions of the engine. The turbo-charger is of conventional design, having a single-stage, axial-flow turbine directly coupled to a radial blower. The rotor assembly, running considerably below the critical speed range, is carried in pressure-lubricated sleeve bearings, the lubricating oil being taken from the main lubricating circuit of the engine.

Fig. 8 shows a nine-cylinder supercharged marine engine, model " RSAD 76," on the test bed. A comparison with Fig. 3 makes clear the difference in the layout of the turbo-charger installation between this engine and the supercharged " SAD 72 " engine. Also noticeable is the different arrangement of the air ducting, leading from the three turbo-chargers to the common air receiver, now located inside the " A "-frames in the space formerly occupied by the scavenging pumps ; one of the two air coolers can be seen at the front end of the engine above the control stand.

The nine-cylinder supercharged version of the model " RSAD " has a normally rated output of 11,700 h.p. at 119 r.p.m. (1300 h.p. per cylinder), which corresponds to a brake mean effective pressure of 7 kg per square centimetre (100 lb per square inch) ; the fuel consumption of 152 grams per horsepower hour (0·34 lb per horsepower hour) is about 6 per cent lower than the best value ever obtained with a non-supercharged engine of this design and compares well with the best results which are known to exist on uniflow-scavenged engines. The absence of visible smoke at this output seems to indicate that the potentialities of this engine have not yet been fully utilised ; indeed, some recent experimental work on a single-cylinder engine gives reason to believe that in future a brake mean effective pressure of 10 kg per square centimetre (145 lb per square inch) might prove to be a workable proposition.

Owing to the success of the supercharged version of the " RSAD " and because of the confidence shipowners have generally placed in supercharged engines, it has become possible to discontinue the construction of large normally aspirated engines. This has permitted the replacement of the " RSAD 76 " by a new engine, the " RD 76," which, exclusively built as a turbo-charged engine of 760mm bore and 1550mm stroke, is considerably simpler in design and has a cleaner external appearance (Fig. 11). As scavenging pumps are no longer needed, the air receiver, formerly located in the framework, is now a separate unit which is attached to the cylinders below the turbo-chargers. The latter are now placed in the most accessible position,

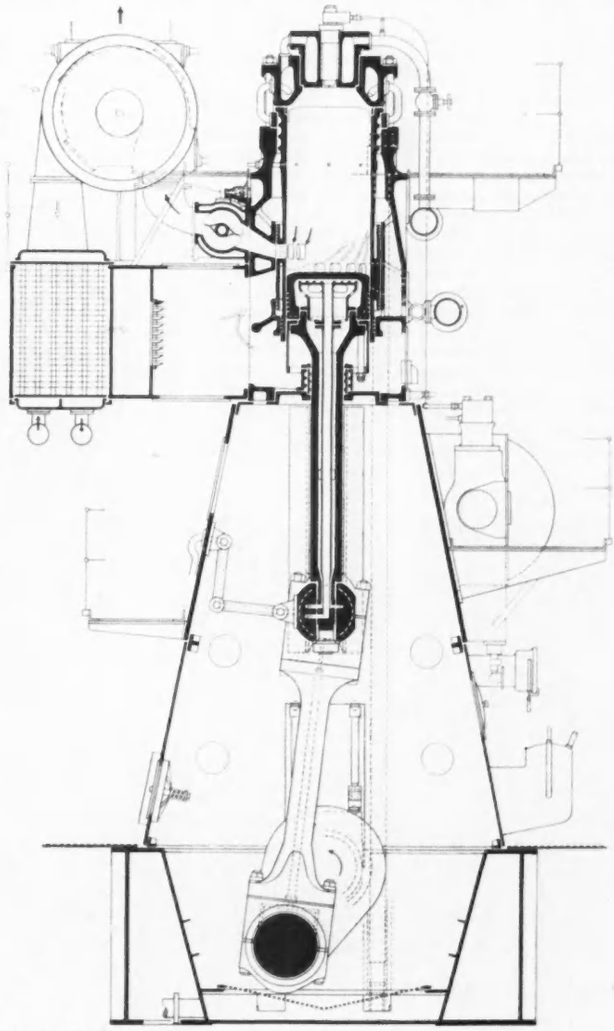


Fig. 11—" RD 76 " turbo-charged engine of 760mm bore and 1550mm stroke, developing 1300 h.p. at 119 r.p.m.

i.e. at the top platform of the engine, and deliver the air direct into the receiver underneath which incorporates the air coolers. The rearrangement of the air receiver made it possible to have a fully symmetrical "A"-frame, eliminating the former cut-out, and to introduce double cross-head guides instead of the former single guide. This layout makes the running gear and the main bearings accessible from either side of the crankcase.

A further change from the original design is the position of the fuel pumps, which have been moved down from cylinder-head level to the second platform, experience with heavy fuel operation having shown that the efficiency of the injection is not adversely affected by lengthening the pipes between the pumps and the injectors. The pumps, formerly distributed over the whole length of the engine, are now mounted in pairs of two and are grouped on a short, gear-driven camshaft. The former oscillating exhaust valve to each cylinder has been replaced by a series of rotary butterfly valves assembled on a common shaft, which is chain-driven off the fuel pump camshaft. As a safety measure, to prevent foreign matter entering the exhaust turbines, the vanes of the butterfly valves are fitted with resilient steel plates which also form an effective rotary seal. With the repositioning of the fuel pumps it has also been found convenient to move the main engine control stand from its former position at the front end to the side of the engine.

The new "RD 76" engine has the same output of about 1300 h.p. at 119 r.p.m. as the former "RSAD 76." The largest Sulzer engine ever built is the "RD 90" engine which is basically similar to the model "RS 76." It has a bore of 900mm, but the same stroke of 1550mm as the "RD 76" and about the same width and height. This engine allows a given output to be concentrated into a smaller number of cylinders, thus reducing the number of moving parts and the length of the engine-room, besides simplifying the maintenance. Two of these engines, at present under construction for British tankers, are expected to give a rated output of 1830 h.p. per cylinder. The manufacturers are convinced this rating could be further increased by the adoption of a higher supercharging level after sufficient additional experience has been gained.

Replaceable Tread Tyre

THE first production examples of a tyre in which the tread is separate from the casing were displayed at Turin by Pirelli, S.p.A., prior to their being put into production in the factories of Société Internationale Pirelli in Great Britain, Argentina, Spain and Brazil. The company has explained that it was to develop this new conception in tyres that participation in racing was discontinued in 1957, despite the fact that every world championship since the war had been won on Pirelli tyres.

As our illustrations show, the BS3 tyre consists of a casing and three tread bands. The casing has four ridges round its circumference to locate the bands, the inner two ridges each having nine gaps. The bands consist principally of rubber, but are based on a series of circumferential metallic cords. The bands are virtually inextensible but can be fitted to the uninflated casing by hand; when the casing is pressurised, the pressure forces are taken by the bands and the bands are immovable on the casing. Only when a puncture has resulted in complete loss of pressure can a band come off in service, and even then, we are advised, the band that is shed does not endanger the vehicle. It will be seen that bands are available in two tread designs: one is conventional and the other concentrates the rubber in large solid blocks which will sink through snow or mud. These latter tread bands do not lap over the ridges locating the bands on the casing: this is to allow spikes to be fitted in the gaps in the ridges, eighteen to each wheel. The spikes are of steel, with a tip of tungsten carbide and a large flat base which fits under the bands. The tread bands are perforce manufactured to standards of accuracy not required in conventional tyres, and hence the dynamic balance of complete tyres is exceptionally good.

From our description it can be deduced that a BS 3 will behave like a rigid breaker tyre: the high resistance to extension of the bands will constrain the outer wall of the casing to resemble a cylinder rather than part of a torus, and prevent the internal pressure causing the tread to become arched in a section including the wheel axis—thus the tread will readily distort from circular in elevation when it is in contact with the ground. The resulting low contact pressure can be expected to result in abnormally high traction, while the reduced shear stress under side forces gives a vastly higher cornering stiffness. The self-aligning torque also is reduced, and it is claimed that even with the tyres at rest steering forces become quite acceptable on normal vehicles. Actual characteristics against slip angle and camber angle have not been made available; it is claimed that the tyre with separate tread bands possesses increased flexibility along an axial plane compared to a classical rigid breaker tyre, and hence it may prove that the BS 3, unlike known rigid breaker tyres, is suitable for single-track vehicles. It is known that the noise level under cornering conditions is low, some 20dB below conventional tyres.

Although, as stated, full friction investigations have not been made or, at least, published, a full-scale test of the tyre with spikes in place has been performed on an ice rink; this showed that a vehicle could be stopped from 25 m.p.h. in 40ft, and that a high braking effort could be applied without the heading of the vehicle changing.

It is expected that a casing will last at least twice as long as a set of treads, and in contrast to the normal tyre the casing does not have to undergo a curing process when a new tread is fitted. It is pointed out that punctures usually occur only when little tread is left on a tyre, so that, even neglecting the increased resistance to penetration of the metal reinforcement, a higher level of safety from deflation can be obtained for similar running cost; each band costs about 12 per cent of the price of a complete tyre. It is, of course, also the case that if a casing is damaged by impact or under-inflation—as usual with rigid breaker designs, the tyres run with a large static deflection—the treads can be salvaged for further use. On vehicles such as those with wishbone independent front suspension, that wear tyres unevenly, it is valuable to be able to change the inner tread band to the outside and vice versa. It is claimed that treads can be removed and replaced in about two minutes. The normal saving in tractive effort with flexible casings is expected with the BS 3.

Production of the new tyre in Great Britain will take place at the Burton-on-Trent factory of Pirelli, Ltd.; initial output will be for 15in wheels.

Stud with tungsten carbide tip for use, with winter tread, on ice

A tyre assembled with winter tread bands and ice spikes

A casing and three bands with the normal tread pattern

Tritium Isotopes Trace Currents in the Baltic

The first institute in Europe for registering the occurrence of tritium in nature has been set up at Frescati, near Stockholm. The establishment of the institute was made possible by contributions from the Wallenberg Fund and the Royal Fund.

Tritium, the radioactive hydrogen isotope, was discovered in 1950 to exist in nature, although previously it had been produced artificially. The quantity was originally very small, but has increased as a result of H-bomb experiments. To be found in all waters, tritium is primarily used for elucidating questions of circulation which were previously difficult to interpret. The institute is at present engaged in an investigation into the circulation of water in the Baltic, which, it is hoped, will make clear the effects of possible discharges of radioactive waste water.

Copper and Brass Tube Mill at New Milford

BY OUR AMERICAN EDITOR

No. II—(*Concluded from page 537, October 30*)

The Scovill Manufacturing Company, of Waterbury, Connecticut, recently opened its new copper and brass tube mill situated on the Housatonic River at New Milford, Connecticut. The works comprise a 293,000 square feet main building situated on a 72-acre site. The mill has been set up with complete integral-unit work centres, instead of the usual "central process" operation with its duplication of similar equipment in one area. This streamlined layout results in a minimum of materials handling. The factory comprises three main bays which handle copper tube, heat exchanger tube and general commercial tube.

THE continuous roller hearth bright annealing convection-heated furnace situated in the finishing line is unusual in that it also generates its own atmosphere. This furnace (Fig. 8) will heat 8000 lb of brass or cupro-nickel per hour at temperatures between 500 deg. Fah. to 760 deg. Cent., and also cool the product to 120 deg. Fah. before it leaves the furnace. Heat is provided by two separate heating systems outside the furnace. Fans in these two heating chambers circulate the products of combustion through the furnace. To provide the continuous supply of atmosphere, the burners in the two firing chambers must be kept firing at all times. Cooling of the gas is accomplished by passing the gas through a chamber cartridge made up of beryl saddles. Precooled water passes down through the saddles and the products of combustion pass upward through the saddles coming in contact with the water, thereby providing the proper amount of cooling. The furnace temperature and gas temperature are controlled by two round chart recorders and a two-point strip chart recorder. Two high-temperature safety controls are also used to shut down the furnace at 800 deg. Cent. The automatic control of this furnace conveyor speed is also obtained by a strip chart speed controller, which indicates and controls the length of time that the material is in the furnace, thereby providing an accurate control of grain size. In both furnaces tubing from 6ft to 60ft long can be processed on a full production basis. The maximum length of tubing is dictated by the length of the charge and discharge tables. The minimum length of tubing is controlled by the space between rollers which are on 12in centres.

Two additional roller hearth annealing furnaces were supplied by the Electric Furnace Company, of Salem, Ohio. The furnace shown in Fig. 9 is used for the bright process and finish annealing of copper tubing in a controlled atmosphere. In addition to handling straight lengths of copper tubing, the equipment is also used to bright anneal single and double pancake coils up to 60in o.d. and bunch coils up to 12in high. The design capacity of the equipment is 9000 lb per hour of straight copper tubing heated to 840 deg. Cent. The usable hearth width is 70in, and the loading and unloading tables are designed for a maximum straight tube length of 30ft. The straight tubes are conveyed through the furnace directly on the hearth rolls, while the coils are placed on light skeleton trays, which ride on the roller hearth. The roller hearth conveyor is equipped with a recording tachometer to record continuously the hearth speed. The equipment is heated by means of gas-fired radiant tubes and is designed to operate in the temperature range of 375 deg. to 900 deg. Cent. Internal forced circulation fans are incorporated into both the heating and cooling sections to obtain the greatest practical heat exchange rate.

In the foreground of Fig. 9 may be seen the cross-over discharge mechanism for straight tubing. As the trailing ends of the tubes emerge from the curtained discharge vestibule, the discharge table is lowered and the tubes deposited on the cross conveyor, which carries the tubing sideways off the discharge table. The table then returns to the normal position to receive the next tubes. The tubes on the cross conveyor may be picked up by slings or, if desired, may be deposited in the cradle shown by advancing the cross conveyor. This equipment is designed to eliminate any scratching or other marking of the finished tubing. Also visible is the small balcony which is installed along the wall behind the furnace equipment. On this balcony are situated the protective atmosphere generation equipment and various other furnace auxiliaries. The atmosphere equipment consists of an exothermic generator of 18,000 cubic feet per hour capacity, which is equipped with a continuous combustibles recorder and controller to vary the air-gas mixing ratio to compensate for any variation in the fuel gas composition. Following the atmosphere generator is a refrigerator gas dehumidifier to lower the dew point of the atmosphere gas to 40 deg. Fah. prior to its introduction into the furnace equipment. Finally, there is a return conveyor to return the empty trays to the charging end of the furnace, and an auxiliary petrol engine to continue driving the hearth rolls in the event of a power failure or other breakdown.

Fig. 10 shows a direct-fired, forced-circulation, roller hearth furnace for the scale-free intermediate annealing and wet quenching of copper or brass alloy tubing. The design capacity of the equipment is approximately 15,000 lb per hour of straight tubing heated to 700 deg. Cent. The usable hearth width is 5ft 8in, and the entire heating section is 38ft 6in long. The heating chamber is divided into four zones, the first of which is separated from the others by a refractory baffle and is arranged for a high heat input capacity. The furnace burners are situated in the side walls, both above and below the work pass line. The burners in the last three zones are two-valve pre-mix equipments. Great flexibility in capacity of the furnace is achieved by arranging the piping of these zones so that on low capacity loading the top or bottom burners may be used independently. The furnace is designed to operate in the temperature range of from 275 deg. to 900 deg. Cent. The second zone is equipped with two forced convection fans, while the third and fourth zones have one convection fan each. The fans provide close temperature uniformity throughout the last three zones even at the lower operating temperatures. The equipment is provided with a longer than usual discharge throat from the heating chamber to provide for the slow cooling of leaded brass and bronze tubing prior to the flood quench. Water curtains and other sealing devices make it practical to maintain a non-scaling atmosphere in the furnace, thereby obtaining a bright anneal on copper tubing even at very low firing rates.

Material Handling

The company decided that the handling of material in the new mill at New Milford would be done most efficiently by overhead electric travelling cranes. The contract to furnish six such cranes was awarded to the Shepard Niles Crane and Hoist Corporation, of Montour Falls, New York. Each crane has a capacity of 10 tons carried on two 5-ton hooks, a height of lift of 28ft, a span of 77ft 2in centre to centre of the runway rails, and a bridge speed of 400ft to 450ft per minute. The principal function of the cranes is to handle bundles of tubes of varying lengths as they progress through the tube producing process. Because of the extreme length of the tubes, two 5-ton hooks are required on each crane to provide two suspension points spaced 24ft apart in order to keep the load in balance. Furthermore, since the tubes must be carried lengthwise of the buildings by the cranes, the hooks have to be in a line at right angles to the crane girders and parallel to the crane runways. To meet these requirements, the crane bridges were designed with an unusually wide

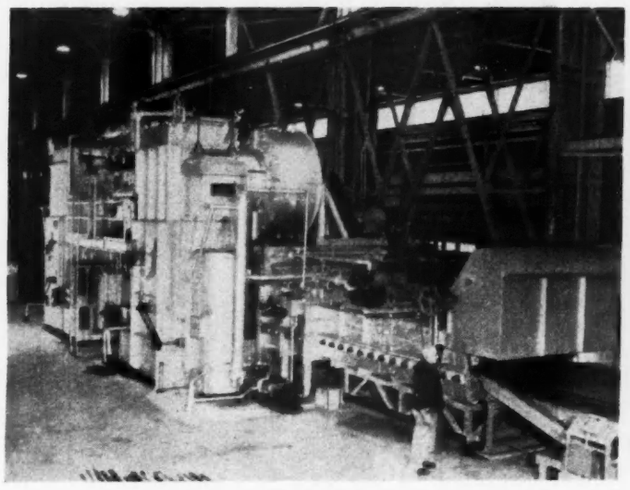


Fig. 8—Surface combustion convection-heated continuous roller hearth furnace for bright finish annealing of brass and cupro-nickel tubing

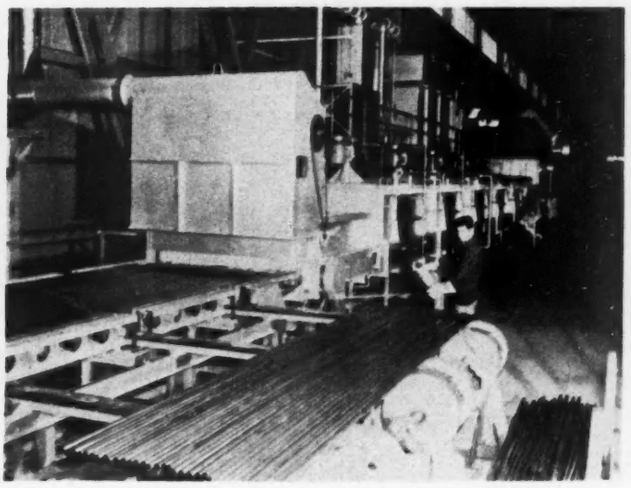
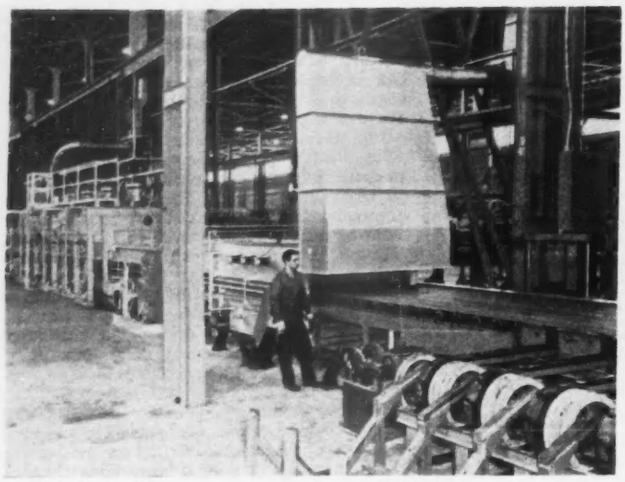
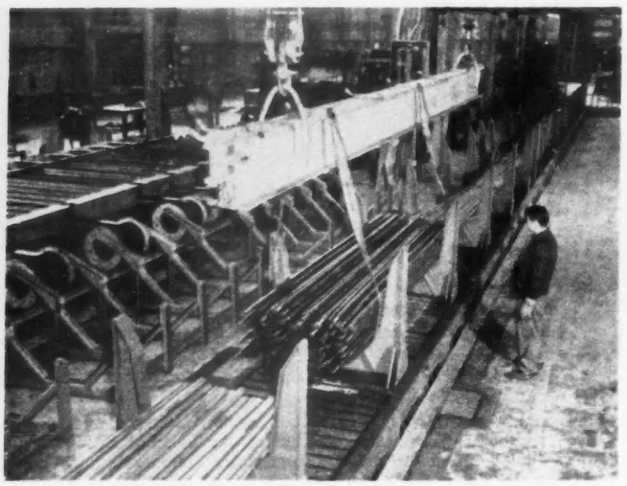


Fig. 9—Continuous roller hearth furnace for bright process and finish annealing of copper tubing





Figs. 10 and 11—(Left) Direct-fired, forced-circulation continuous roller hearth furnace for bright intermediate annealing and wet quenching of copper and brass tubing. (Right) Reversible bay transfer conveyor capable of handling five 10,000 lb bundles of tubing at a time

spacing of 30ft centre to centre of main girders and an extremely long wheelbase of 35ft at the bogie ends. Travelling on top of these main girders of each crane and across the width of the building is a specially designed trolley which consists of a supporting frame similar to a crane bridge with a span of 30ft complete with its own drive unit, cross shafting and wheels. On this trolley are mounted the two hoisting mechanisms with winding drums spaced 24ft apart, to provide the two-point suspension and the hook lift of 28ft. In addition, each hoist unit on each trolley is equipped with its own motor, gearing, brake and control so that the hook can be operated independently of or simultaneously with the other hook on the same trolley. In this way the load can be raised horizontally or tilted at one end or the other, depending on the requirements of the manufacturing process.

In addition to material handling by means of overhead electric travelling cranes, several special Mathews transfer conveyors were also installed for handling. Fig. 11 illustrates the twin reversible bay-transfer conveyors which may be considered to be an unusual application of a slat-type chain pallet conveyor. The two 130ft long conveyors are used to transfer bundles of tubing, weighing up to 10,000 lb, from one crane bay to another. These bundles, ranging in length from 12ft to 60ft, are deposited by overhead crane into bucks attached to the conveyor chain on 8ft centres. The conveyor is energised to move each bundle to a position where it can be picked up by another crane serving the adjacent building bay. Flat tread plates mounted across the chains between the carrying bucks serve as a moving safety platform for the people working in the area. Each conveyor, with drive mechanisms situated at either end, is designed to move a total of five 10,000 lb loads in either direction.

In addition, a 40ft long motor-driven transfer car is provided for the movement of crane-sling loads of tubing from one bay to another. This transfer car is equipped with a series of structural steel bucks and operates through a distance of approximately 20ft by riding on rails which are set flush in the floor.

The tube annealing furnaces are served by live roller charge and delivery tables. The charge tables are about 70ft long and comprise conventional chain-driven live roller conveyors with a 70in face width between flanges mounted at the ends of each roller. The furnace delivery table rollers, for a distance of approximately 14ft from the discharge of the furnace, are individually equipped with over-running clutches to facilitate the separation of batches of tubing coming from the furnace for transferring at right angles off the tables into bucks at the sides of the table. The entire table can be driven at furnace speed from the furnace conveyor drive, or the last 65ft can be driven by means of its own separate drive at a speed of 20ft per minute. This last 65ft length is also mounted on a hydraulically-operated wedge mechanism which will lower a batch or batches of tubing on to Micarta-topped, reversible, cross transfer chains for delivery into the side bucks.

Pointing Equipment

Pointing is a fundamental operation prior to drawing in the manufacture of brass alloy or copper tubing. This operation has in the past been done usually by manual feeding to swagers or large squeeze-type pointers. At New Milford, the pointing operations on large diameters of tubing have been mechanised to a point of near automation, completely eliminating the drudgery of manual feeding and with much greater production speed and accuracy. These modern tube pointers are built around large four-die swaging machines equipped with a hydraulically-actuated feed. Large bundles of tubing are delivered to the feed platform by overhead material handling equipment. A single operator simply assists each tube length to roll into the jaws of the feeder. The feeder then takes over and the pointing operation is completely automatic, even to the unloading. The pointed pile of tubing is then picked up by the overhead crane and transported to its next operation. Fig. 12 shows 3¼in diameter by ⅜in wall thickness tubing being pointed to 1⅝in. A production speed of approximately four points per minute is being maintained on this large size of tubing, a production rate far greater than that obtainable with former methods.

Sawing Equipment

The circular sawing machines employed in the two main cut-off installations at New Milford were furnished by the Loma Machine Manufacturing Company, of New York (Fig. 13). They have a swinging arm mounted above the saw table, effecting the cutting stroke in a downward direction. The operation of each saw is arranged for a semi-automatic cycle. The feed

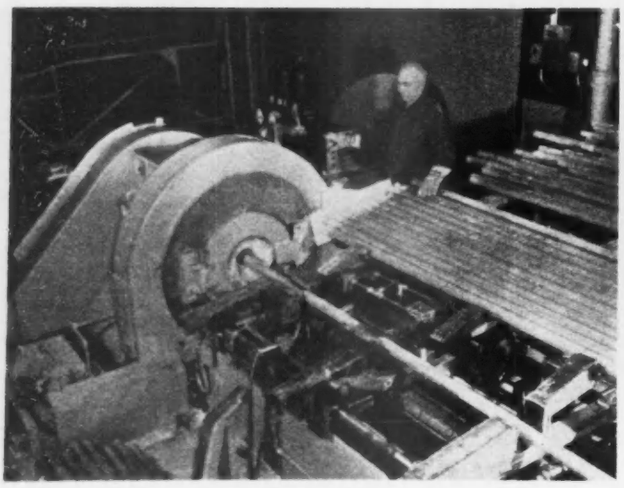


Fig. 12—Swaging machine with mechanised feeding equipment for pointing 3¼in diameter tubing

Fig. 13—Circular saw tube cut-off installation with feeding and discharge conveyors

and clamp movements are adjustable both in its upper and lower limit to suit the tube diameter and the exact size of the sawblade. The saw feed movement is controlled by a flow control valve inserted in the circuit of a hydraulic cylinder which is coupled to the air cylinder. The saw feed speed can thereby be preset to a speed appropriate to the duty required. This predetermined feed speed results in a considerable saving in sawblade cost, since with correct setting no overloading of the sawblade can occur, as is often the case with manually operated feed movement. Both machines employ 14in diameter blades driven by 10 h.p. motors at up to 8000ft per minute. The saws are equipped with a double stock clamp performing a downward clamping movement. In the closed position, the clamp grips the stock firmly on either side of the sawblade. This design results in a perfect cut which is almost free of burr. The movement of the clamps is adjustable and can be limited to prevent undue deformation of thin-walled tubing. Rubber pads inserted into the clamp enhance the gripping action without risk of deformation and marking of stock.

The cutting cycle is started by the operator pressing a push-button, whereupon the clamp closes. The saw arm does not start on its cutting movement until the clamps are fully closed and, vice versa, the stock is not released from the clamps until the saw arm has swung back in its rest position. A stop device is built into the exit conveyor ; the position of the stop is adjustable to the desired cut-off length and acts by means of electric relays on the two pinch roller sets in such a way that the advance movement of the tubes is automatically stopped in the correct position. There is a second adjustable stop in the runout table to handle odd lengths which remain from the full length stock when the last cut is made. The cut tubes of the full length are automatically pulled out of the saw by the pinch rollers instantaneously after the cut has been made and are ejected from the roller table by means of air-operated tilt levers. The tubes are deposited by crane on loading racks alongside the entrance table, and, in order to facilitate the alignment of the tube, or the tubes in the case of multiple cut, on the entrance table, an "unscrambling" device is employed. This device consists of a vertical pin which moves at high speed in a guide between the entrance table and the storage rack. The operator has but to flip over to the table the first end of the stock which is then separated from the pile of tubes on the storage rack. Thus, even if the tubes in one load are entangled, they are readily separated for the cut.

Straightening Equipment

Three high-speed tube straighteners at New Milford are capable of straightening tubes from $\frac{3}{8}$in to $2\frac{1}{2}$in diameter at linear speeds up to 500ft per minute. Each machine passes the copper or brass tube through six horizontal rolls and then six vertical rolls in a staggered arrangement (Fig. 14). The straightening machines were supplied by the Torrington Manufacturing Company, of Torrington, Connecticut. The tube-size capacity ratings of the three straighteners are based on a nominal yield point of 60,000 lb per square inch in the material being straightened. In order of increasing machine size, these tube capacities are $\frac{3}{8}$in to 1in by 0·065in maximum wall ; $\frac{1}{2}$in to 2in by 0·083in maximum wall ; and 1in to $2\frac{1}{2}$in by 0·095in maximum wall. The corresponding roll diameters are 4in, $5\frac{1}{2}$in, and $6\frac{1}{2}$in. The smallest machine is driven by a 10 h.p. motor at a roll surface speed of 500ft per minute, while the two larger straighteners are driven at 400ft per minute by motors of 20 h.p. and 30 h.p. respectively. The rolls are mounted on tapered roller bearings and are overhung to provide quick and easy changing from one set to another. Half of the rolls in each plane are individually adjustable by handwheels, and a lock is provided to maintain the adjusted position.

Testing Equipment

In the production of highest quality tubes used in such fields as condenser, refrigerator air conditioning and similar applications, it is most important to employ a foolproof method for testing the tubes under internal pressure. Only a combined test under water and air pressure will detect extremely small leaks. The combination testing machine at New Milford was supplied by the Loma Machine Manufacturing Company, of New York, and allows this double test to be performed in a single unit (Fig. 15). The machine has a very high output capacity of approximately 400 tubes per hour with the tubes held for ten seconds under air pressure: it is controlled by automatic cycling so that the operator can concentrate his attention on the observation of the tube being tested. The operational sequence of the machine can be varied as required. The tester can handle a range from $\frac{1}{2}$in to $1\frac{1}{2}$in o.d. in lengths up to 100ft. The machine represents a self-contained unit consisting of the testing machine proper, material handling facilities, and the oil-hydraulic power unit with a motor-operated pump producing the oil pressure for an intensifier from which the water is supplied for the hydraulic test at variable pressures up to 7000 lb per square inch. A rotating movement is employed to transport the stock from the air test at 500 lb per square inch to the water test positions, and the machine is designed as a double head machine for the simultaneous testing of pairs of tubes. The high output rate is facilitated by the automatic control of all machine movements, and this output can be predetermined for each condition by an adjustable preset enforced cycle time.

In addition to pneumatic and hydrostatic testing, Scovill also employs an eddy current electronic tube tester developed recently by the Magnetic Analysis Corporation, of Long Island City, New York, and now accepted as a production inspection method. The use of this instrument has not only made possible an improvement in the quality of material supplied to customers by the elimination of defective tubes, but it has also made possible the maintenance of a specific quality level.

Waste Treatment Plant

The liquid industrial wastes which occur at the new mill are of two general kinds : (*a*) weak wastes which are discharged continuously from rinses during pickling and dichromate brightening operations ; and (*b*) strong solutions of spent pickling acid and dichromate brighteners which are discharged at intermittent intervals. Both of these wastes contain higher concentrations of copper, zinc, chromium and sulphuric acid than is permitted by the State Water Commission of Connecticut in waste waters discharged to the Housatonic River.

The weak rinse waters discharged continuously from pickling and dichromating operations flow to an open earth basin in which they are agitated by means of compressed air to minimise fluctuations in pH and temperature. The wastes are pumped from the basin to a mixing tank in the treatment building where sufficient lime is added to raise the pH of the wastes to 9·5. The treated wastes then flow to a combination flocculation and clarification unit where the copper, zinc and chromium hydroxides produced by the addition of the lime are coagulated and permitted to settle. The clear liquid overflow from this unit then flows to the main works drain and on to the Housatonic River. The sludge which has settled flows to open sludge lagoons where it is concentrated by seepage, evaporation and decanting.

The strong spent pickling acid is given separate pretreatment. Because a common collection system is used to convey all industrial wastes to the treatment plant, this highly concentrated acid can be dumped only during those periods when there is no flow of weak rinse waters or other wastes to the wastes collection system. During such periods, the concentrated wastes are diverted to a sump at the treatment plant and from there are pumped into a storage tank. When weak wastes are again discharged to the treatment plant, the spent acid is pumped at a slow and controlled rate to the mixing tank for treatment with the weak wastes. Spent concentrated dichromate brighteners are also isolated and treated in the same manner as the concentrated pickling acids. In this case, however, sodium bisulphite is first added to the dichromate brighteners to reduce the hexavalent chromium to trivalent chromium. Sulphuric acid is also added to aid the chemical reaction.

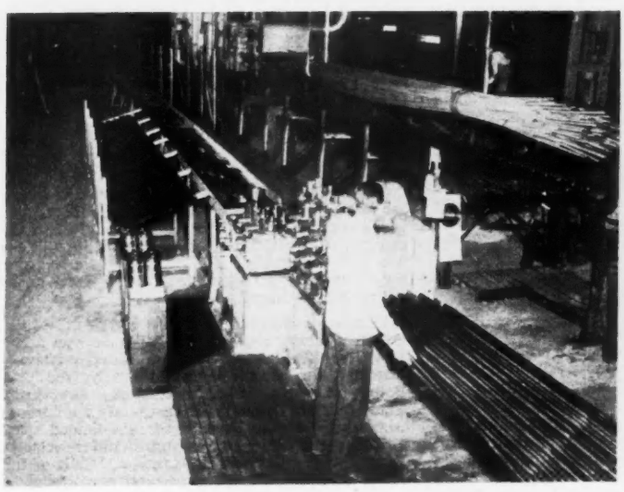


Fig. 14—High-speed tube straightening machine with six horizontal and six vertical rolls

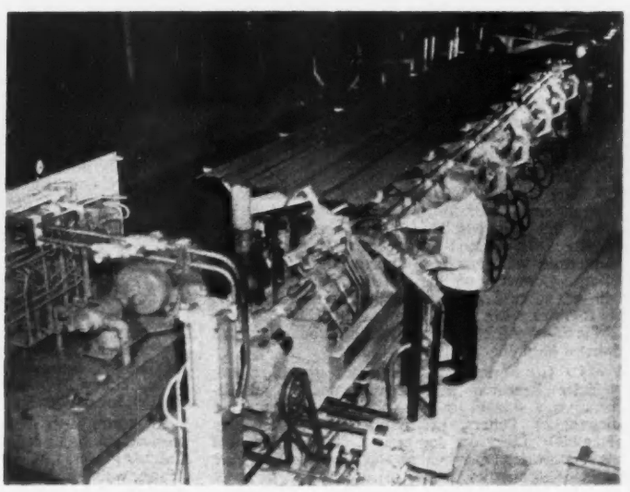


Fig. 15—Combination hydrostatic and pneumatic tube testing machine with a capacity of 400 tubes per hour

Personal and Business

Appointments

THE SOLARTRON ELECTRONIC GROUP, Ltd., has announced the appointment of Mr. Anthony Cockle as reliability engineer.

AIR CONTROL INSTALLATIONS, Ltd., announces that Mr. D. G. Hill has been appointed manager of the air filter department.

A.E.I. LAMP AND LIGHTING COMPANY, Ltd., has announced the appointment of Mr. T. A. F. Gooch as assistant sales manager.

MR. ELLIS RAWDIN BROWN, M.I.Mech.E., has been appointed works manager, Crewe, London Midland Region, British Railways.

WICKMAN, Ltd., announces the appointment of Mr. R. J. Dixon as director and general manager of its Machine Tool Manufacturing Company.

MR. JOHN HARRISON has been appointed managing director of Atlas Copco (Great Britain), Ltd., in succession to Mr. J. C. Greig, who has resigned.

MR. W. R. HART has been elected president of the Office Appliance and Business Equipment Trades Association for 1959–60, in succession to Mr. B. F. Levett.

MR. JAMES E. ROBINSON, M.I.Mech.E., M.I.Mar.E., chief engineer of Hepworth and Grandage, Ltd., has been appointed to the company's board of directors.

THE MINISTRY OF EDUCATION announces that Mr. Denzil K. Freeth, M.P., has been appointed parliamentary private secretary to Sir David Eccles, Minister of Education.

THE CENTRAL ELECTRICITY GENERATING BOARD announces that Mr. H. B. Dreyfus, M.I.E.E., has been appointed system design and development engineer of the Board.

EASTERN REGION, BRITISH RAILWAYS, announces the appointment of Mr. E. H. Ker as locomotive engineer in the department of the chief mechanical and electrical engineer.

FORD MOTOR COMPANY, Ltd., announces that Mr. J. N. Lampson has been appointed manager of the public relations department, tractor division, in succession to Mr. E. B. Black, who has retired.

MR. F. H. BEASANT, M.I.Mech.E., M.I.E.E., has returned to England from Australia, to take up an appointment as deputy manager of the traction division of the Brush Electrical Engineering Company.

MR. ERNEST TURNER JONES, F.R.Ae.S., deputy controller (overseas affairs), Ministry of Aviation of the United Kingdom, has been elected deputy chairman of the N.A.T.O. Advisory Group for Aeronautical Research and Development.

CROMPTON PARKINSON, Ltd., announces that Mr. E. C. Holroyde has resigned as a vice-chairman and director at his own request, to allow for the appointment of younger men. Mr. Michael Parkinson has been elected a vice-chairman and Mr. J. B. Scott a director.

THE EASTERN REGION OF BRITISH RAILWAYS announces the appointment of Mr. C. F. Rose, A.M.I.Mech.E., as mechanical and electrical engineer (development) in the department of the chief mechanical and electrical engineer. Mr. G. C. Gold, M.I. Loco.E., has been appointed mechanical and electrical engineer (workshops).

MR. E. W. PARRY, engineering manager and director of Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., has been elected chairman of the National Association of Marine Enginebuilders, in succession to Mr. James Ferrier. Mr. D. G. Ogilvie, managing director of Hawthorn Leslie (Engineers), Ltd., has been elected vice-chairman.

THE ENGLISH ELECTRIC COMPANY, Ltd., states that, following the retirement of Mr. C. M. Cock as general manager of the traction department at the end of this year, Mr. H. J. H. Nethersole has been appointed as general manager of traction. Mr. Nethersole will remain a director of The English Electric Company of South Africa (Pty.), Ltd., but will be succeeded as managing director by Mr. R. B. Price. Mr. L. L. Brinkworth, chief engineer of the South African company, will become technical director on January 1, 1960.

MR. E. MASTERS, director of the Fighting Vehicles Research and Development Establishment, is to take up the position of managing director of Petters, Ltd., and Hawker Siddeley (Hamble), Ltd., on January 1, 1960. He will also become a member of the board of Hawker Siddeley Industries, Ltd. Mr. Masters succeeds Mr. D. K. Fraser, who has resigned his various directorships with the Hawker Siddeley Group on being appointed a joint managing director of G. A. Harvey and Co. (London).

LONDON TRANSPORT announces the following appointments in the department of the chief civil engineer: Mr. E. W. Gain, A.M.I.C.E., has been appointed an officer of the executive with the title of works and building engineer; Mr. F. S. P. Turner, A.M.I.C.E., has been appointed an officer of the executive with the title of assistant new works engineer.

Business Announcements

MR. T. W. HEATHER, assistant managing director of The General Electric Company, Ltd., retired on October 31.

COLLOIDAL GRAPHITE, Ltd., states that its offices and factory have been transferred to Sheaf Island Works, Pond Hill, Sheffield, 1 (telephone, Sheffield 27397).

MESSRS. HUME AND TOTTENHAM, architects and engineers, announce that they have opened an office at 1–2, Hertford Place, London, W.1 (telephone, Euston 8321).

HILGER AND WATTS, Ltd., 98, St. Pancras Way, Camden Road, London, N.W.1, has acquired the whole of the issued share capital of the Infra-Red Development Company, Ltd., Welwyn Garden City.

JONES, STROUD AND CO., Ltd., Highfield Mills, Canal Street, Long Eaton, Nottingham, states that it has taken over the whole of the glass tape weaving operation previously undertaken by Fibreglass, Ltd., Glasgow.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., London, and Alco Products Incorporated, New York, announce that an arrangement has been made for joint collaboration in design, manufacture and sale of diesel-electric locomotives for world markets.

THE PRESS AND SHEAR MACHINERY COMPANY, Ltd., 172–178, Victoria Road, Acton, London, W.3, states that it has been appointed the exclusive distributor in the United Kingdom for the "Bruderer" range of high precision automatic punching presses.

THE PLESSEY COMPANY, Ltd., states that The Amar Tool and Gauge Company, Ltd., of Chadwell Heath, Essex, will now be grouped for administrative purposes with the industrial hydraulics division and the sheet metal division at Cheney Manor, Swindon, under the overall management of Mr. E. H. Y. Burden.

RESEARCH AND CONTROL INSTRUMENTS, Ltd., Instrument House, 207, King's Cross Road, London, W.C.1, states that it is the sole distributor in the United Kingdom for the industrial products previously marketed by its associated company, Philips Electrical, Ltd. Mr. C. W. V. Davis is to head the newly-formed industrial products division.

HUMPHREYS AND GLASGOW, Ltd., announces that its agreement with Alco Products Incorporated, New York, in connection with nuclear power station units of up to 30MW capacity has been terminated by mutual consent. Humphreys and Glasgow is prepared to offer a similar range of comprehensive power stations incorporating pressurised water reactors designed and manufactured by Babcock and Wilcox, Ltd.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH announces that with the appointment of Lord Hailsham as the Minister with general responsibility for science and technology, including atomic energy, the Atomic Energy Office and the Lord President's Office will be combined. The new office will be in the charge of Mr. F. F. Turnbull, whose appointment as deputy secretary, to succeed Sir Friston How in charge of the Atomic Energy Office, was announced some months ago. It will be organised in two divisions: (1) a general division, under Mr. R. N. Quirk, under-secretary, corresponding to the previous Lord President's Office; and (2) an atomic energy division, under Mr. M. I. Michaels, under-secretary, corresponding to the previous Atomic Energy Office.

Contracts

BROWN AND TAWSE PLANT, Ltd., West Gorton, Manchester, has received an order for six "Hydrocon Highlander" 5-ton rotary hydraulic full-circle-slewing mobile cranes from British Railways, North Eastern Region, for use by the Civil Engineering Department.

RANSOMES AND RAPIER, Ltd., of Ipswich, has received an order valued at 1,500,000 dollars from Calgary Power, Ltd., Alberta, for a large electrically-driven walking dragline. The "RapieR W1350" machine to be supplied weighs 1400 tons and will be equipped with a 33 cubic yard bucket capable of carrying 50 tons of material at a time at a radius of 215ft.

TANGYES, Ltd., Smethwick, Birmingham, has been awarded a contract for the supply of hydraulic equipment to Canada Iron Foundries, Ltd., the manufacturers of the tunnelling shields for excavating the Bloor University Avenue subway in Toronto. The equipment consists of cylinders and rams, erector arms and hydraulic pumps, and the order is valued at 600,000 dollars.

HEAD WRIGHTSON IRON AND STEEL WORKS ENGINEERING, Ltd., a subsidiary of Head Wrightson and Co., Ltd., has received an order from Colvilles, Ltd., for the supply and construction of a blast furnace gas cleaning plant at Ravenscraig, Scotland. The plant will mostly be manufactured at the Head Wrightson works on Teeside. The value of this contract is approximately £357,000.

RICHARD COSTAIN (AFRICA), has been awarded a £750,000 contract for the construction of 30 miles of main road between Salisbury and Lusaka near to the Kariba Dam. Heavy earthworks through 4½ miles of the Zambesi escarpment involve the removal of 750,000 cubic yards of muck and rock; one major bridge of prestressed design, thirty large box culverts and 200 pipe culverts are also to be built. Work starts in November and is due for completion early in 1962.

WHATLINGS, Ltd., is the contractor for the construction of the northern section of the Ayr-Prestwick by-pass in Ayrshire. The scheme involves the provision of dual 24ft carriageways with a central reservation of 15ft, the construction of three roundabouts and four bridges, one of which will be an overline railway bridge and another a road-over-road bridge. The overall length of the scheme is 4½ miles. It will be supervised by Ayr County Council, acting as agents for the Secretary of State for Scotland. The estimated cost is £706,000 and it is hoped that the work will be completed in twenty-one months.

THE GENERAL ELECTRIC COMPANY, Ltd., in association with Vacuum Industrial Applications, Ltd., has received an order from the National Physical Laboratory for a 2-litre vacuum arc-melting furnace. The furnace will be used for melting and casting refractory metals such as titanium, niobium and molybdenum. The power is being supplied by a 2000A, 40V germanium rectifier unit. The rectifier output is controlled by means of a saturable reactor connected in the primary side of the rectifier transformer enabling the output current to be varied from 500A up to 2000A. The power unit has a short time overload capacity of 2500A.

THE GENERAL ELECTRIC COMPANY, Ltd., has received two contracts for electric winders to the value of £250,000 for installation at gold mines associated with Anglo American Corporation of South Africa, Ltd. The first contract is for the supply of one 10ft 6in by 6ft by 6ft 4500 h.p. Blair-type (twin rope) hoist for President Steyn Gold Mining Company, Ltd. In connection with this contract, the order for the mechanical parts has been received from The Vanderbijl Engineering Corporation of South Africa, Ltd., and these will be manufactured in South Africa to designs produced at the Erith Engineering Works of G.E.C. The electrical parts have been ordered direct by President Steyn Gold Mining Company, Ltd., and will be designed and manufactured at the Witton Engineering Works of G.E.C. The second contract is for the supply of mechanical parts only of two 12ft diameter by 5ft wide, 1100 h.p. double-drum hoists for Western Deep Levels, Ltd. These hoists will be manufactured in South Africa to the designs of the Erith Engineering Works of G.E.C.

Miscellanea

CAN FILLING MACHINE.—In the description of the can filling machine made by Mather and Platt, Ltd., which appeared in our issue of October 16 last, the capacity of the machine for pint and half-pint cans was given incorrectly. The capacity of the machine for these sizes of can is expected to be 300 per minute; not per hour as stated.

HIGHER CAPACITY TRACTION BATTERIES.—After extensive laboratory and field trials, a new "N" range of "Kathanode" traction batteries is being marketed for general industrial use by the D.P. Battery Company, Ltd., Bakewell, Derbyshire. These cells are designed for heavy-duty applications where high capacity is required in a limited space and are particularly suited to electric delivery vehicles, factory trucks and mine locomotives. Cells of this range embody pasted positive and negative plates with improved grid alloys and active materials compounded to new formulæ. Triple separation is provided by ribbed "Porvic," glass wool sheets and cedar veneers.

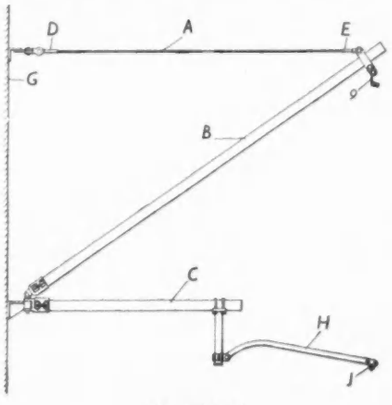
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

RAILWAY ELECTRIFICATION

821,264. December 4, 1957.—Overhead Electrification Systems for Railways, British Insulated Callender's Cables, Ltd., Norfolk House, Norfolk Street, London, W.C.2, and British Transport Commission, 222, Marylebone Road, London, N.W.1. (*Inventors: Arthur George Sweetland, Clifford Edwin Ricketts, John Alan Broughall and Raymond Pattison.*)

In accordance with this invention an improved form of cantilever structure for supporting railway catenaries is provided in which the strut, the tie member and at least the inner part of the registration arm each comprise a rod or tube fabricated from resin-bonded glass fibre. With this construction the need for heavy porcelain compression insulators and strain insulators hitherto required for high voltage overhead systems is eliminated and since the resin-bonded glass fibre rod or tube has a density of the order of 0·06 lb per cubic inch compared with 0·25 lb per cubic inch for mild steel, a structure which is much lighter and which is resistant to corrosion is obtained. Referring to the drawing, the principal



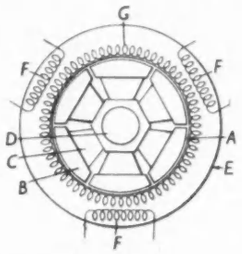
No. 821,264

structural elements are three resin-bonded glass fibre rods, a rod *A* of small cross-section which forms the tie rod, a rod *B* of larger cross-section which forms the strut and a rod *C* of the same cross-section as the rod *B*, which forms the inner registration arm. Attached to both ends of the tie rod are compression fittings *D* and *E*. Surface *G* may be a mast or for example the wall of a cutting, a tunnel wall, a bridge truss or a bracket supported on any of these or projecting downwards from the roof of a bridge. At the end of the registration arm *H* is mounted a swivel clip *J* for the contact wire.—*October* 7, 1959.

ELECTRICAL ENGINEERING

821,432. January 11, 1957.—Electric Motors, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. (*Inventors: Joseph Pritchard Huggard and Peter Scott.*)

This invention relates to alternating or pulsating current electric motors. In some circumstances, for example in the case of an electrically driven winch, a load normally driven by a motor may run away if the power supply fails and means, such as automatically operating mechanical brakes, must be provided. It is an object of the present invention to provide an alternating or pulsating current electric motor which is capable itself of providing a braking effect if the supply to the motor fails. The drawing shows a three-phase machine embodying this principle. The rotor component *A* is provided with a permanent magnet field system which is multi-polar; in the example shown, there are six salient pole shoes *B* secured through respective permanent magnets *C* to a shaft *D*. The magnetic field from the pole shoes intersects the windings of the stator component *E*. There are two of these windings, one winding *F* being a three-phase winding arranged to be energised from a main three-phase supply so that the motor operates under normal conditions as a synchronous machine. The speed of the motor may then be varied by arranging for the supply to be of variable frequency. The other winding of the stator is a closed circuit winding *G*. The winding *F* is arranged in any standard known manner on the stator component and, depending upon this arrangement, the closed circuit winding *G* may conveniently be associated with the winding *F* by being wound in some or all of the slots of the three-phase winding.



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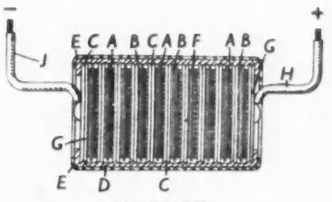
The winding *G* is designed to provide a closed circuit for emergency braking upon failure of the main supply. If this occurs while the motor is driving the load, so that the rotor is rotated by the load as it commences to run away, the interaction of the permanent magnet field system of the rotor with the winding *G* is arranged to produce a braking effect, dependent upon the power dissipation in the closed circuit winding.—*October* 7, 1959.

821,572. January 15, 1958.—Electric Batteries, The Chloride Electrical Storage Company, Ltd., 50, Grosvenor Gardens, London, S.W.1. (*Inventors: Harold Britnor Lunn and Sydney Reginald Weston.*)

This invention relates to electric batteries of the type embodying plates of the duplex or bipolar type in which plates of opposite polarity are attached to opposite sides of a conductor plate which is impervious to and not attacked by the electrolyte. The invention is applicable to alkaline, lead acid and other batteries. Referring to the drawing, each bipolar unit is made by attaching the positive plates *A* and negative plates *B* to the opposite faces of a rigid conductor disc *C* as for example by spot welding. The periphery of each disc is grooved to form a "V," and the inter-cell seal is effected by maintaining pressure between the peripheral ridges of the grooves and a tube *D* of deformable material which retains its deformed shape under continued pressure. The pressure of the material of the tube on the peripheral ridges of the discs *C* is applied and maintained by forcing the tube into an outer



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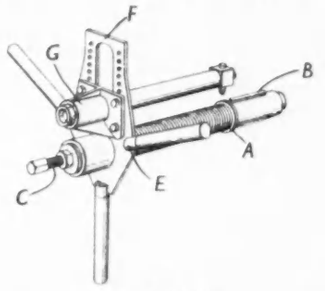
rigid tube or container *E* of a suitable diameter to give the requisite pressure seal. Alternatively the outer tube may be shrunk on to the inner tube. The assembly is stack built, the duplex elements being interleaved with suitable separators *F*. To complete the assembly, both ends of the plastic tube and the steel tube are turned over around the two end discs *G* and after fixing the terminal leads *H* and *J* to the end discs the battery is then complete. The presence of the inner tube *D* completely insulates the outer metal container *E* so that corrosion of the outer case is minimised, as is the risk of discharging one battery due to contact with another. For ease of sealing, a cylindrical tubular construction is to be preferred but the battery may be, for example, of square or rectangular cross section.—*October* 7, 1959.

PIPE TOOLS

821,862. January 9, 1958.—Portable Device for Turning the Ends of Pipes, Pass and Co., Ltd., Station Works, Denton, Manchester. (*Inventor: Frank Cooke.*)

In the drawings, a device for turning the ends of pipes and the like in accordance with this invention comprises a support in the form of a hollow tubular metal member *A* which is threaded over approximately two-thirds of its length. In the plain end three slots *B* are disposed equidistantly around the member. Extending through the support is a clamping rod *C*, the inner end of which is enlarged and of conical form. At its other end, the clamping rod is threaded, so that when a nut is rotated on it the clamping rod will be drawn along longitudinally within the support member for its conical end to force wedges out of the support slots. A tool-holder of the device comprises a threaded bush which screws on the support and is secured to or formed integrally with a plate which has sockets *E* for operating handles. This plate has a wide extension *F* which is slotted and has a number of closely spaced bolt-holes along each side. Secured to the extension is a flanged sleeve *G* which supports a tool bar. The tool bar has, at its end, a socket for a conventional cutting tool, as shown. When the device is used for turning the end of a pipe the plain



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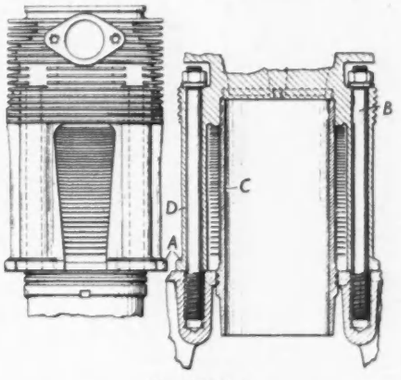
end of the support, with the wedge-shaped elements, is inserted into the end of the pipe and the nut on the clamping rod rotated to move the wedges outwards to clamp the device to the inside of the pipe. The bush of the tool-holder is then screwed on to the end of the support and rotated to bring the cutting tool into close proximity with the outer surface of the pipe. The position of the tool can then be adjusted to effect a suitable cut by varying the position of the sleeve *G* on the extension and the tool in its socket. The tool-holder is then rotated by the handles and progresses along the threaded support with the tool making a cut any desired length along the end of the pipe. This is repeated according to the amount by which it is desired to reduce the outside diameter of the pipe.—*October* 14, 1959.

INTERNAL COMBUSTION ENGINES

821,994. January 31, 1958.—Air-Cooled Internal Combustion Engines, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

According to the invention, in an internal combustion engine, the cylinder head and a cylinder housing are formed by a one-piece structure, preferably of light-metal, secured on the crankcase by studs which extend at least into the region of the cylinder head, and a cylinder liner with cooling fins is inserted within the housing and secured at one end to the cylinder head. With this simple and light construction, the cylinder is prevented from being subjected to tension when the engine is in operation. The forces are transmitted from the cylinder head directly by the studs so that neither the liner nor the housing itself is subjected to tension. The liner is not subjected to any stresses and the housing, due to prestressing of the studs after insertion, is subjected to com-



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pressive stress only. The cylinder housing and cylinder head form a one-piece structure of light-metal, mounted by means of a flange *A* on the crankcase. Studs *B* screwed into the crankcase extend into the region of the cylinder head and nuts on the upper end secure the structure with compressive prestressing of the cylinder portion, on the crankcase. Screwed in the cylinder-head is the upper end of a liner *C* whose lower end can slide freely under expansion into the crankcase, the lower end being provided with packing rings, as shown, to seal it. The liner carries fins which the cooling air reaches through a wide opening in the cylinder housing. The studs are passed through holes in bulges *D* formed on the structure comprising the cylinder housing and cylinder head.—*October* 14, 1959.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Nov. 6.—LIVERPOOL AND DISTRICT BRANCH: Industrial Development Centre, M.A.N.W.E.B., Paradise Street, Liverpool, Discussion on "Education and Training for the Electrical Industry," 7.30 p.m.

Mon., Nov. 9.—BOURNEMOUTH AND DISTRICT BRANCH: Grand Hotel, Firvale Road, Bournemouth, "The Development of Motor Control Centres." 8 p.m. ★ CENTRAL LONDON BRANCH: White Hall Hotel, Bloomsbury Square, London, W.C.1, "The Duties of an M.P. Inside and Outside Parliament," R. Ledger, 7.15 p.m. ★ NORTH WEST LONDON BRANCH: Century Hotel, Wembley, "Nuclear Power Stations," L. E. C. Hughes, 8.15 p.m.

Tues., Nov. 10.—CHESTER AND DISTRICT BRANCH: Westminster Hotel, City Road, Chester, "H.R.C. Fuses," E. Jacks, 7.45 p.m. ★ PORTSMOUTH AND DISTRICT BRANCH: Offices of the Ministry of Labour and National Service, Lake Road, Portsmouth, "Switchgear," 7.30 p.m. ★ SOUTH WALES BRANCH: Angel Hotel, Cardiff, Colour film of the 1959 Electrical Engineers (A.S.E.E.) Exhibition, P. A. Thorogood, 7.30 p.m. ★ WEST KENT BRANCH: Royal Star Hotel, Maidstone, "Electricity Distribution in Kent," H. F. Knell, 7.30 p.m. ★ YORK BRANCH: Georgian House, Blossom Street, York, "Diesel-Electric Locomotives," F. H. Woods, 7.30 p.m.

Wed., Nov. 11.—BIRMINGHAM BRANCH: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Protective Equipment for Industrial Plant," W. L. Stern, 7.30 p.m. ★ LUTON BRANCH: College of Technology, Park Square, Luton, "The Aims and Workings of the Electrical Association for Women," Miss A. S. Lockhart, 8.15 p.m. ★ SOUTH EAST LONDON BRANCH: Eltham Green School, Queenscroft Road, Eltham, London, S.E.9, "Marine Propellers," J. M. Langham, 7.45 p.m.

Thurs., Nov. 12.—BRADFORD AND DISTRICT BRANCH: Midland Hotel, Bradford, Discussion on I.E.E. Regulations, J. L. Browell, 7.30 p.m. ★ SOUTH WEST LONDON BRANCH: Prince of Wales Hotel, London, S.W.19, Branch Lecturette Competition, 7.45 p.m.

BRITISH COKE RESEARCH ASSOCIATION

Wed., Nov. 11.—Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1, Joint Technical Meeting with the Institution of Gas Engineers and the Coke Oven Managers' Association, "The First Year at the Coke Research Centre," G. W. Lee, 2.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Tues., Nov. 10.—MERSEYSIDE SECTION: University Club, 2, Mount Pleasant, Liverpool, "The Use of Transistors in Communications and Control," E. Wolfendale, 7 p.m.

Wed., Nov. 11.—MEDICAL ELECTRONICS GROUP: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Physiological and Acoustical Aspects of Hearing," R. P. Gannon, 6.30 p.m. ★ SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Transistor and its Use in Communication and Control Equipment," E. Wolfendale, 7 p.m. ★ NORTH EASTERN SECTION: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, "Electronic Welding Controls," C. R. Bates, 6 p.m. ★ WEST MIDLANDS SECTION: Wolverhampton and Staffordshire College of Technology, Wulfruna Street, Wolverhampton, "Recent Developments in Semiconductor Rectifiers," 7.15 p.m.

Thurs., Nov. 12.—SCOTTISH SECTION: Department of Natural Philosophy, The University, Drummond Street, Edinburgh, "The Transistor and its Use in Communication and Control Equipment," E. Wolfendale, 7 p.m. ★ NORTH WESTERN SECTION: Reynolds Hall, College of Technology, Sackville Street, Manchester, "Progress in Permanent Magnet Materials," J. E. Gould, 6.30 p.m.

ENGINEERING METROLOGY ASSOCIATION

Thurs., Nov. 12.—Great Hall, Northampton College of Advanced Technology St. John Street, London, E.C.1, "The Application of Accurate Measurement to Production Engineering," J. Loxham, 7 p.m.

ILLUMINATING ENGINEERING SOCIETY

Tues., Nov. 10.—LONDON CENTRE: Federation of British Industries, Tothill Street, London, S.W.1, "Research in Phosphors," A. H. McKeag, 6 p.m.

Thurs., Nov. 12.—MANCHESTER CENTRE: Free Trade Hall, Manchester, "Lighting for Production," W. R. Stevens, 7 p.m. ★ NOTTINGHAM CENTRE: Electricity Centre, Carrington Street, Nottingham, "Illuminated Ceilings," W. J. Walpole, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Thurs., Nov. 12.—BEDS AND HERTS SECTION: Evening visit to the Norton Grinding Wheel Company, Ltd., Welwyn Garden City, Herts, 7 p.m.

Mon., Nov. 16.—EAST ANGLIAN SECTION: Lecture Hall, Public Library, Ipswich, "Precision Castings," J. S. Turnbull, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Nov. 10.—JUNIOR LECTURE: East Ham Technical College, London, E.6, "Atomic Energy," K. Maddocks, 7.15 p.m. ★ LONDON LECTURE: Memorial Building, 76, Mark Lane, London, E.C.3, "The Design of a Resonance Changer to Overcome Excessive Axial Vibration of Propeller Shafting," A. J. H. Goodwin, 5.30 p.m.

Wed., Nov. 11.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Notes on Development, Design and Operation of Harbour and Coastal Tugs," R. Beattie, 7.30 p.m.

INSTITUTE OF METAL FINISHING

Wed., Nov. 11.—ORGANIC FINISHING GROUP: British Institute of Management, 80, Fetter Lane, London, E.C.4, "Pre-Treatment Methods and Choice for Organic Finishing," D. H. Lloyd and N. J. Heslop, 6.30 p.m.

INSTITUTE OF METALS

Thurs., Nov. 12.—METAL PHYSICS COMMITTEE: Royal Institution, 21, Albemarle Street, London, W.1, Symposium on "The Application of Thin-Film Techniques to the Electron-Microscopic Examination of Metals," 9.30 a.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Nov. 9.—WEST REGIONAL CENTRE: Liverpool Architectural Society's Rooms, Bluecoat Chambers, School Lane, Liverpool, 1, "Air Suspension," V. E. Gough, 7.30 p.m.

Tues., Nov. 10.—MIDLANDS CENTRE: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, "Air Suspension," V. E. Gough, 7.30 p.m.

Wed., Nov. 11.—EAST MIDLANDS CENTRE: Mechanics' Institute, Nottingham, "Recent Development in Fuel Injection Pump Design," 7.30 p.m. ★ SOUTHERN CENTRE: Cambridge Hotel, Southsea, "Development of Motive Power for Lifeboats," R. A. Gould, 7.30 p.m. ★ SOUTH EASTERN GROUP: Saracen's Head Hotel, Ashford, "Research and Test Procedure in Connection with Automotive Fuels," L. P. F. Drake, 7.30 p.m.

Fri., Nov. 13.—SOUTH WALES CENTRE: South Wales Institute of Engineers, Park Place, Cardiff, "Transport Painting," E. J. Robins, 7.15 p.m.

Mon., Nov. 16.—SCOTTISH CENTRE: North British Hotel, Princes Street, Edinburgh, "Diesel Power Units," D. Kaberry, 7.30 p.m.

INSTITUTE OF SHEET METAL ENGINEERING

Wed. and Thurs., Nov. 11 and 12.—Charing Cross Hotel, London, W.C.2, Annual Autumn Conference, 10.30 a.m.

INSTITUTE OF WELDING

Wed., Nov. 11.—SOUTH LONDON BRANCH: 54, Princes Gate, London, S.W.7, "Welding and Lloyd's," G. M. Boyd, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Nov. 10.—Great George Street, Westminster, London, S.W.1, "Planning for the Ultimate Hydraulic Development of the Nile Valley," H. A. W. Morrice and W. N. Allan, 5.30 p.m.

Thurs., Nov. 12.—Great George Street, Westminster, London, S.W.1, Informal Discussion on "Track Maintenance and Renewal, with Particular Reference to Length of Possession," introduced by F. Fawcett and W. F. Beatty, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Nov. 6.—MERSEY AND N. WALES CENTRE: Talbot Hotel, Wrexham, "Discrimination Between H.R.C. Fuses," E. Jacks, 7 p.m.

Mon., Nov. 9.—ELECTRONICS AND COMMUNICATIONS SECTION: Savoy Place, London, W.C.2, "Theory of the Travelling-Wave Parametric Amplifier," A. L. Cullen; "The Gain of Travelling-Wave Ferromagnetic Amplifiers," P. J. Il. Clarricoats; "Some Properties of Travelling-Wave Resonance," J. R. G. Twisleton; and "Saturation Effects in a Travelling-Wave Parametric Amplifier," A. Jurkus, 5.30 p.m. ★ EAST ANGLIAN SUB-CENTRE: Electric House, Ipswich, "The Influence of Consumers' Load/Consumption Characteristics on Metering Practice," L. B. S. Golds, 6.30 p.m. ★ MERSEY AND N. WALES CENTRE: Bluecoat Chambers, School Lane, Liverpool, "The Provision of Adequate Electrical Installations in Buildings": (*a*) "Multi-Storey Flats and Maisonettes," C. A. Belcher; (*b*) "Houses," C. Hyams; (*c*) "Commercial Buildings," E. E. Jacobi, and (*d*) "Small Industrial Premises," J. A. Sharp, 6 p.m. ★ NORTH-EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, "Electrical Supplies to Power Station Auxiliaries," D. A. Dewison, 6.15 p.m. ★ SOUTH MIDLAND SUPPLY AND UTILISATION GROUP: College of Technology, Gosta Green, Birmingham, "Research on the Performance of High-Voltage Insulators in Polluted Atmospheres," J. S. Forrest, P. J. Lambeth and D. F. Oakeshott, 6 p.m. ★ WESTERN CENTRE: Electricity House, Bristol, "Subscriber Trunk Dialling," D. A. Barron, 6 p.m. ★ WESTERN UTILIZATION GROUP: Technical College, Bath, "The Deltic Locomotive," C. M. Cock, 6 p.m.

Tues., Nov. 10.—NORTH-EASTERN CENTRE: College of Further Education, Workington, "The Provision of Adequate Electrical Installations in Buildings—Small Industrial Premises," J. A. Sharp, 7 p.m. ★ NORTH WESTERN UTILIZATION GROUP: Engineers' Club, Albert Square, Manchester, "The Provision of Adequate Electrical Installations in Buildings"—"Multi-Storey Flats and Maisonettes," C. A. Belcher, and "Commercial Buildings," E. E. Jacobi, 6.15 p.m. ★ NORTHERN IRELAND CENTRE: David Keir Building, Queen's University, Stranmillis Road, Belfast, "The Provision of Adequate Electrical Installations in Buildings," C. C. Hyams, 6.30 p.m. ★ SOUTH MIDLAND CENTRE: Victoria Technical Institute Worcester, "The Deltic Locomotive," C. M. Cock, 7.30 p.m.

Wed., Nov. 11.—SUPPLY SECTION: Savoy Place, London, W.C.2, "Generator/Motor Problems in Pumped-Storage Installations," J. H. Walker, 5.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: The Temple, Dale Street, Liverpool, Joint Meeting with the Liverpool Engineering Society, "Vision and Position—Two Electronic Aids to Marine Navigation," R. B. Mitchell and C. Powell, 6 p.m. ★ NORTH-WESTERN ELECTRONICS AND COMMUNICATIONS GROUP: Engineers' Club, Albert Square, Manchester, "Auroron," C. B. Watkins, 6.15 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: North-Western Electricity Board Demonstration Theatre, North Road, Lancaster, "H.V. D.C. Transmission, with Special Reference to the Cross Channel Cable," F. J. Lane, 7.15 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE: Carlton Hotel, North Bridge, Edinburgh, "A New Method for Observing the Phenomena of Commutation," H. J. H. Sketch, P. A. Shaw and R. J. K. Splatt, 7 p.m. ★ RUGBY SUB-CENTRE: College of Technology and Arts, Rugby, Joint Meeting with the Graduate and Student Section, "The Universe Explored by Radio Astronomy," F. C. Smith, 6.30 p.m. ★ SOUTHERN CENTRE: S.E.B. Showrooms, 17, New Canal, Salisbury, "The Planning and Installation of a Television Transmitting Station," D. B. Weigall, 6.30 p.m. ★ OXFORD DISTRICT BRANCH: S.E.B. Service Centre, 37, George Street, Oxford, "Modern Coal-Fired Power Station," A. E. Hawkins, 7 p.m.

Thurs., Nov. 12.—UTILIZATION SECTION: Savoy Place, London, W.C.2, "Submersible Pumping Plant," H. H. Anderson and W. G. Crawford, 5.30 p.m. ★ NORTH SCOTLAND SUB-CENTRE: Electrical Engineering Dept., Queen's College, Dundee, "The Application of Transistors to Line Communication Equipment," H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead, 7 p.m. ★ SOUTH-WESTERN SUB-CENTRE: Electric Hall, Upper Union Street, Torquay, "Subscriber Trunk Dialling," D. A. Barron, 3 p.m. ★ WEST WALES (SWANSEA) SUB-CENTRE: Conference Room, S.W.E.B. Showrooms, The Kingsway, Swansea, "A Review of Work Towards Nuclear Energy from Controlled Thermonuclear Reaction," D. W. Fry, 6 p.m.

Fri., Nov. 13.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, "The Application of Transistors to Line Communication Equipment," H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead, 7.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, Nov. 6.—LONDON BRANCH: Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Some Aspects of the Design of Road Improvements in an Urban Area," S. E. French, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Sat., Nov. 7.—SOUTHERN GRADUATES' SECTION: Visit to Hamworthy Engineering Company, Ltd., 2.30 p.m.

Tues., Nov. 10.—AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, "Vehicle Head Lamp Beam Control," K. R. Jones, and "Measurement of Driver Visibility and its Application to a Visibility Standard," R. A. C. Fosberry and B. C. Mills, 6 p.m. ★ SOUTHERN GRADUATES' SECTION: Technical College, Brighton, "Diesel Engines for Small Cars," M. H. Howarth and C. J. Walder, 7 p.m.

Wed., Nov. 11.—ORDINARY MEETING IN CONJUNCTION WITH THE LUBRICATION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "Extreme Pressure Lubricants for Marine Gears," A. D. Newman, 6 p.m. ★ EASTERN GRADUATES' SECTION: Afternoon visit to W. H. Allen Sons and Co., Ltd., Queens Engineering Works, Bedford.

Thurs., Nov. 12.—STEAM GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Pipe and Tube Welds on Site," 6 p.m. ★ NORTH WESTERN BRANCH: Engineers' Club, Albert Square, Manchester, "Reduction of Engine Noise," A. J. King, 6.45 p.m. ★ SCOTTISH BRANCH: Technical College, Dundee, "The Jodrell Bank Radiotelescope," H. C. Husband, 7.30 p.m. ★ YORKSHIRE BRANCH: The University, Leeds, "Vertical Take-Off by Jet Lift," D. Keith-Lucas, 6.30 p.m. ★ EASTERN GRADUATES' SECTION: Visit to U.S.A.F. Base, Bentwaters, near Woodbridge, 7.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION: College of Art, Green Lane, Derby, Joint Meeting with the local section of the Institution of Civil Engineers, Discussion on "Future of Transport," 7.15 p.m.

Fri., Nov. 13.—SCOTTISH BRANCH: North British Hotel, Edinburgh, "The Jodrell Bank Radiotelescope," H. C. Husband, 6.30 p.m.

Sat., Nov. 14.—EAST MIDLANDS GRADUATES' SECTION: Visit to John Taylor and Co., Bell Foundry, Loughborough, 10 a.m.

Mon., Nov. 16.—MIDLAND GRADUATES' SECTION: Birmingham, Exchange and Engineering Centre, Stephenson Place, Birmingham, "Interior Space Problems in Vehicle Design," B. C. Mills, 7 p.m.

INSTITUTION OF PLANT ENGINEERS

To-day, Nov. 6.—WEST AND EAST YORKSHIRE BRANCH: Houldsworth School of Applied Science, The University, Leeds, "Design and Operation of the Jodrell Bank Radio Telescope," C. N. Kington, 7.30 p.m.

Tues., Nov. 10.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Oil Firing of Industrial Boilers," H. A. Cheetham, 7.15 p.m.

Wed., Nov. 11.—EAST MIDLANDS BRANCH: Sherwood Room, County Hotel, Theatre Square, Nottingham, "Motor Vehicle Development," Mr. Martland, 7 p.m. ★ WESTERN BRANCH: Grand Hotel, Broad Street, Bristol, "Developments in the Gas Industry," W. A. Simmonds, 7.15 p.m.

Thurs., Nov. 12.—GLASGOW BRANCH: Scottish Building Centre, 425/427, Sauchiehall Street, Glasgow, "Nuclear Power," F. A. Walker, 7.15 p.m. ★ NORTH EAST BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, "Glass," E. L. Luckner, 7 p.m. ★ SHEFFIELD AND DISTRICT BRANCH: Blue Bell Hotel, Scunthorpe, "The Role of the Central Engineering Workshops in the Maintenance Problem," G. C. Oram, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Nov. 9.—EAST AND WEST RIDINGS REGION: Grand Hotel, Sheffield, "Pre-Stressed Rolling Mill," W. Udall, 6.30 p.m.

Tues., Nov. 10.—EAST AND WEST RIDINGS REGION: Technical College, Doncaster, "Operational Research," D. Hicks, 7 p.m. ★ MANCHESTER GRADUATE SECTION: Reynolds Hall, College of Science and Technology, Sackville Street, Manchester, "Modern Steel Production," F. C. Martin, 7.15 p.m.

Wed., Nov. 11.—MIDLANDS REGION: Dudley and Staffs Technical College, Wolverhampton, Film Evening, 7.15 p.m. ★ NORTH WESTERN REGION: Accrington College of Further Education, Sandy Lane, Accrington, Lancs, "Metrology and Industrial Measurement," P. W. Harrison, 7.30 p.m. ★ LONDON GRADUATE SECTION: 10, Chesterfield Street, Mayfair, London, W.1, "The Manufacture of Precision Ball and Roller Bearings," T. J. Williams, 7.15 p.m.

Fri., Nov. 13.—EASTERN REGION: Golden Lion Hotel, Cornhill, Ipswich, "High Education with particular reference to Production Engineering," F. Metcalf, 7.30 p.m.

Mon., Nov. 16.—EAST AND WEST RIDINGS REGION: Percival Whitley College of Further Education, Francis Street, Halifax, "Electronic Copying on Machine Tools," R. Lawson, 7.30 p.m. ★ NORTH WESTERN REGION: Grand Hotel, Hanley, Stoke-on-Trent, "Glass in Industry," J. G. Window, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Nov. 9.—MIDLAND SECTION: Grand Hotel, Birmingham, "Towards the Quantitative Understanding of Rubbers," G. Gee, 6.45 p.m.

Tues., Nov. 10.—LONDON SECTION: Royal Society of Tropical Medicine and Hygiene, Manson House, 26, Portland Place, London, W.1, "The Utilisation of Man-Made Fibres in the Rubber Industry," G. A. Pittman, 7 p.m.

Wed., Nov. 11.—WEST OF ENGLAND SECTION: George Hotel, Trowbridge, "Recent Developments in Butyl Rubber," 7.45 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Nov. 6.—MIDLAND COUNTIES BRANCH (GRADUATES' AND STUDENTS' SECTION): Birmingham Exchange and Engineering Centre, Birmingham, "Some Features of the Design, Construction and Operation of the 8ft by 8ft Supersonic Wind Tunnel at R.A.E. Bedford," T. Barnes and J. Y. G. Evans, 6.30 p.m.

Tues., Nov. 10.—MIDLAND COUNTIES' BRANCH (GRADUATES' AND STUDENTS' SECTION): Electricity Demonstration Hall, Ironeate, Derby, "Concrete Reconstruction in Coventry," N. Rayman, 6.15 p.m.

Thurs., Nov. 12.—LONDON BRANCH: 11, Upper Belgrave Street, London, S.W.1, "The North Western Gas Board's New Coal Carbonising Plant at Garston," H. G. Cousins, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 6.—Pepys House, 14, Rochester Row, London, S.W.1, Films, "Mirror in the Sky"; "Ultrasonics," and "Conquest of the Atom," 7 p.m.

Mon., Nov. 9.—SHEFFIELD SECTION: Livesey Clegg House, 44, Union Street, Sheffield, 1, President's Address, "Electricity Supplies to Large Electric Arc Furnaces," A. Haddock, 7.30 p.m.

Fri., Nov. 13.—Pepys House, 14, Rochester Row, London, S.W.1, Chairman's Address, "Electronic Components," W. C. C. Ball, 7 p.m. ★ NORTH WESTERN SECTION: Engineers' Club, Albert Square, Manchester, "Manufacture of Nylon Polymer," R. C. Spooncer, 7.30 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Wed., Nov. 11.—Picton Library, Liverpool, Joint meeting with the Institute of Welding, "Welding in Warship Construction," W. R. Seward, 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Nov. 13.—Engineers' Club, Albert Square, Manchester, 2, Discussion on the proposed Incorporation of the Association, 6.45 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Nov. 13.—Lecture Theatre, Mining Institute, Neville Hall, Newcastle upon Tyne, "Ship Model Size and Tank Boundary Correction," A. Emerson, 6.15 p.m.

ROYAL AERONAUTICAL SOCIETY

Wed., Nov. 11.—Library, 4, Hamilton Place, London, W.1, "The Flight Testing of Rotorcraft," W. R. Gellatly, 7.30 p.m.

Fri., Nov. 13.—AGRICULTURAL AVIATION GROUP: Library, 4, Hamilton Place, London, W.1, Discussion on the International Conference at Cranfield, 7 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., Nov. 9.—12, Great George Street, Westminster, London, S.W.1, Presidential Address, J. L. Postlethwaite, 5.45 p.m.

ROYAL SOCIETY OF ARTS

Mon., Nov. 9.—CANTOR LECTURE: John Adam Street, London, W.C.2, "Education for Industry and Commerce," A. A. Part, 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Thurs., Nov. 12.—CONTROL SECTION: Manson House, 26, Portland Place, London, W.1, "Optimum Setting of Water Turbine Governors," H. Schiott, 7 p.m.

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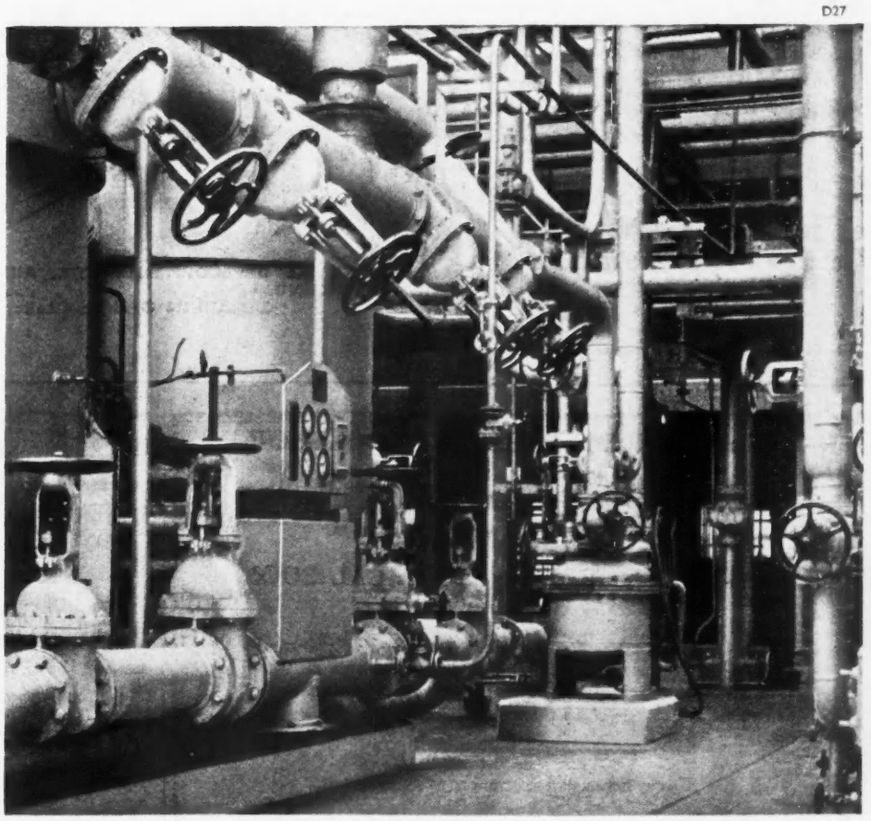

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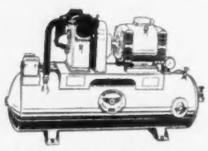

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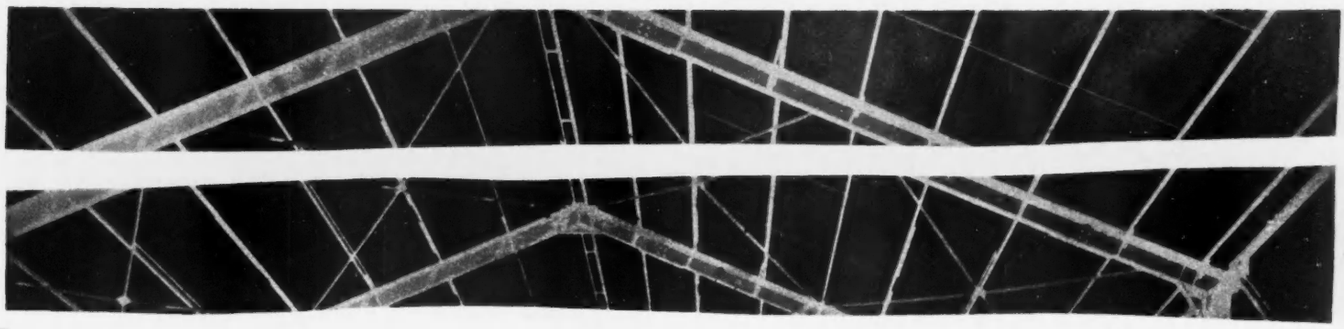

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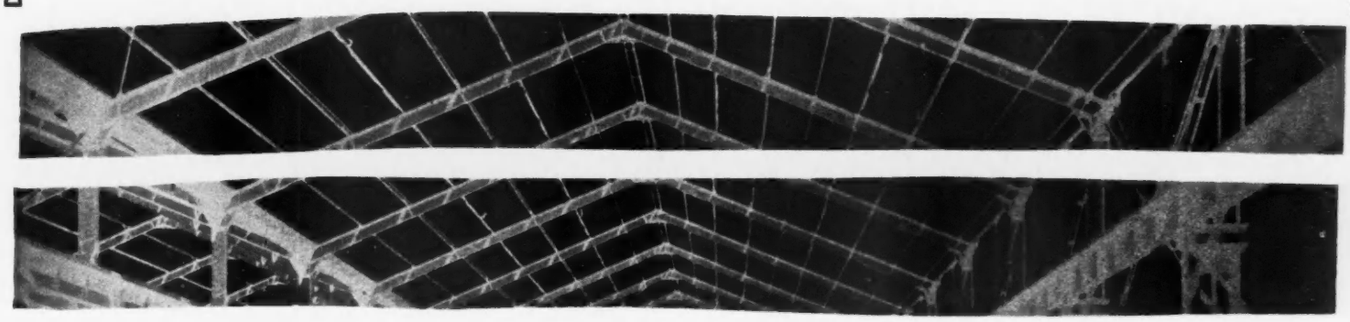

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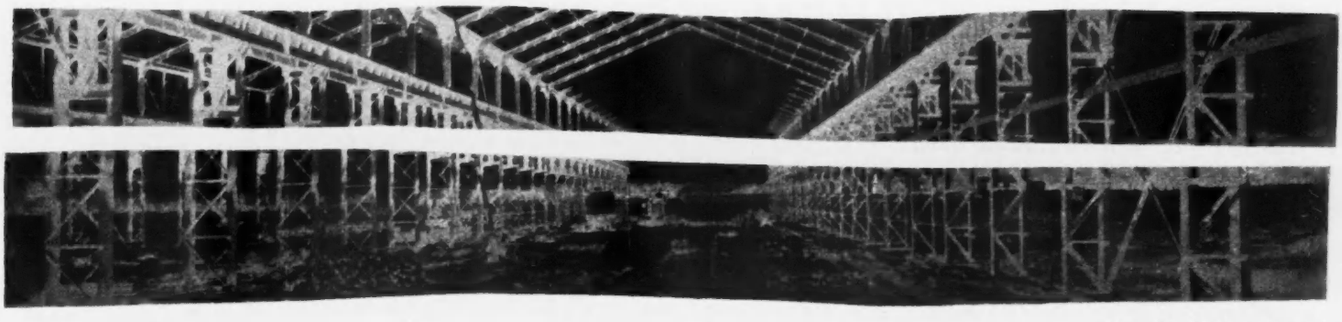

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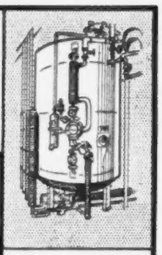

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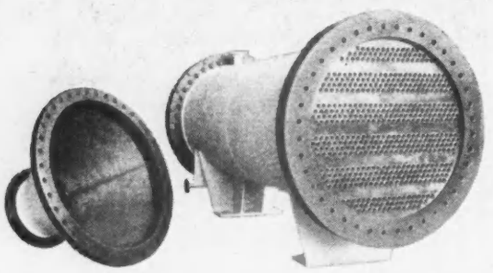

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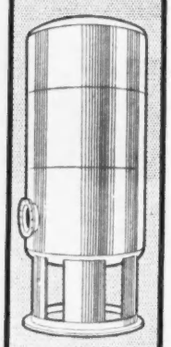

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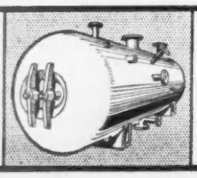

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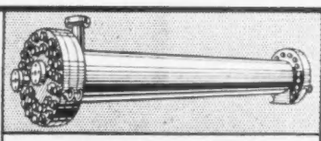

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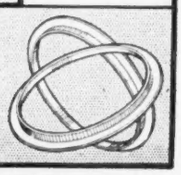

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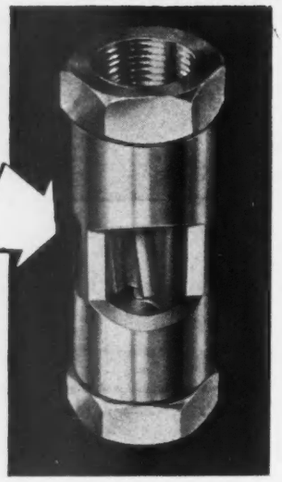

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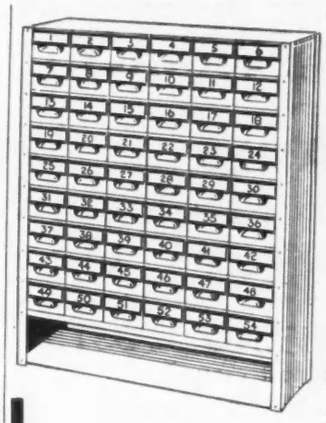

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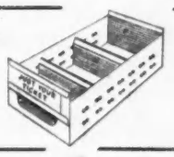

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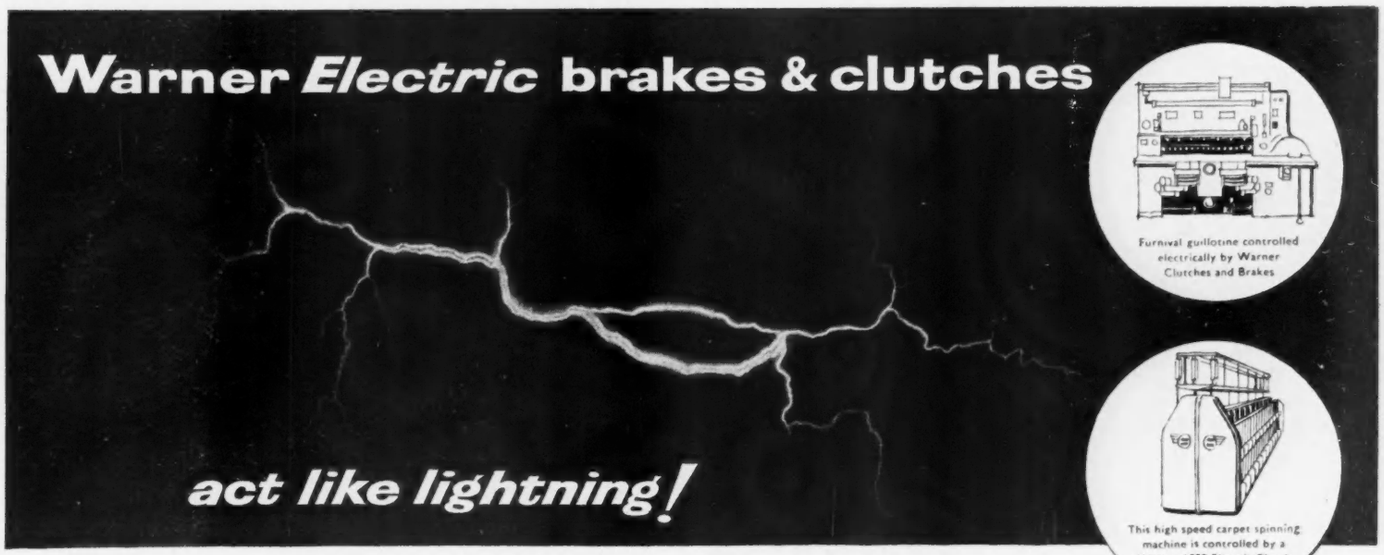

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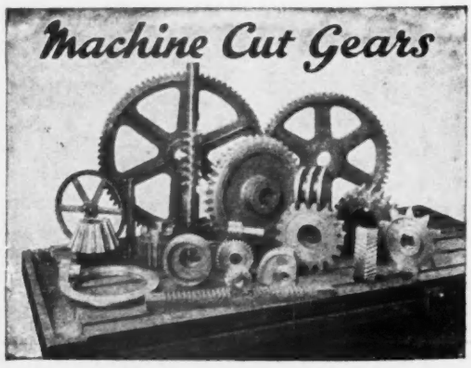

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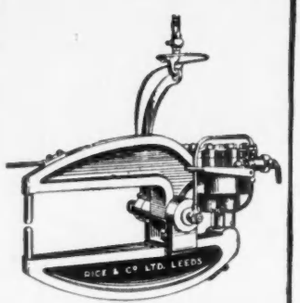

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1'-6" to 3'-9" Gap. 20 to 30 tons power.

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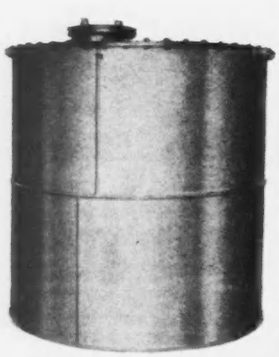

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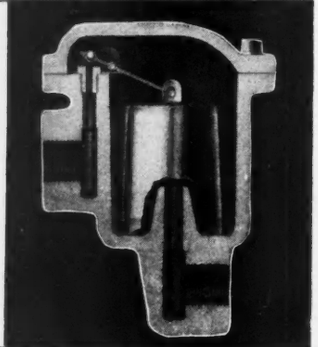

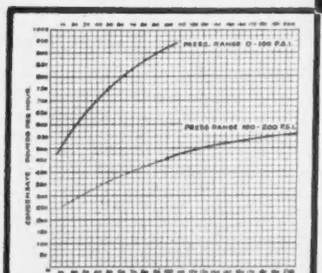

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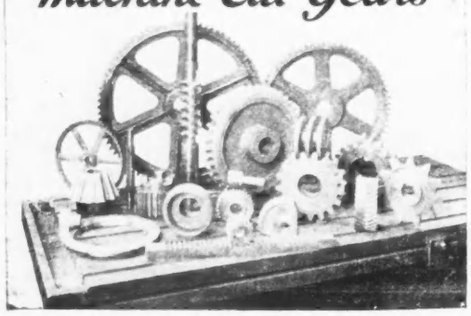

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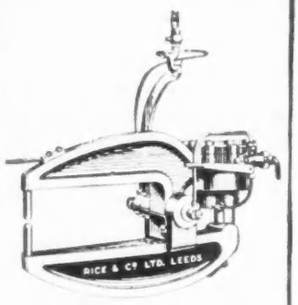

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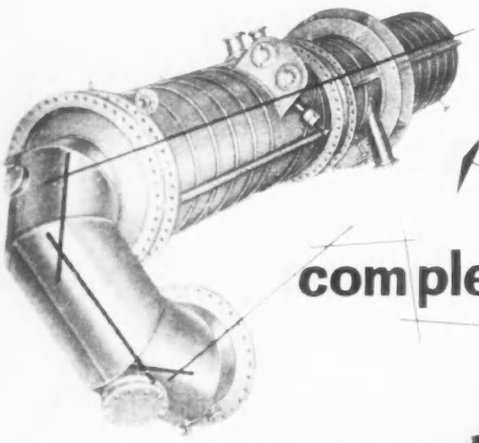

complexity

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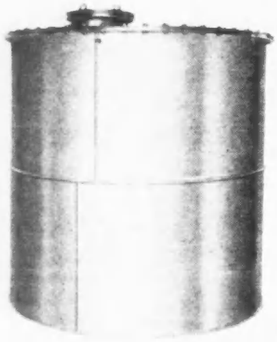

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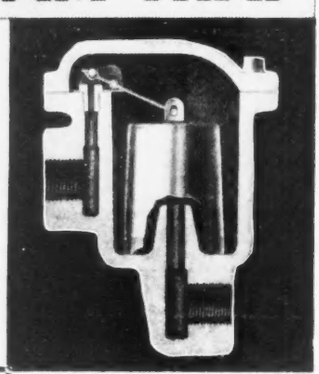

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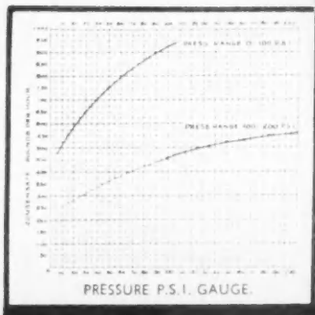

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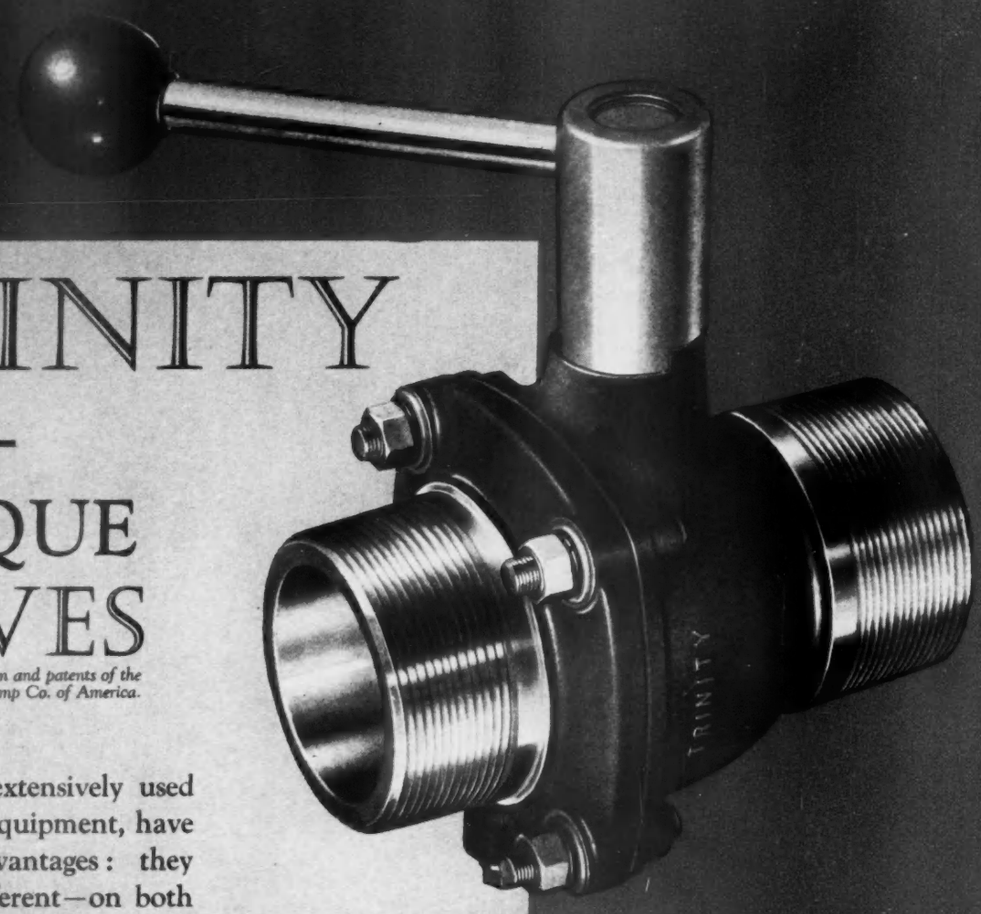

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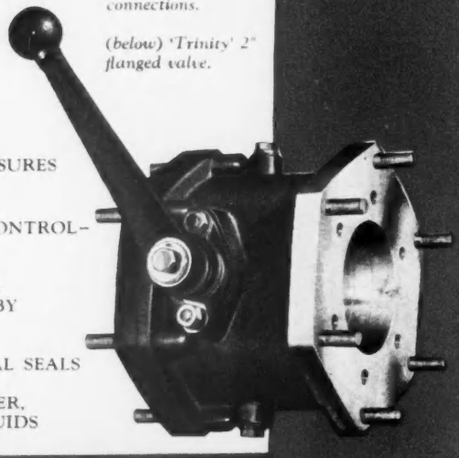

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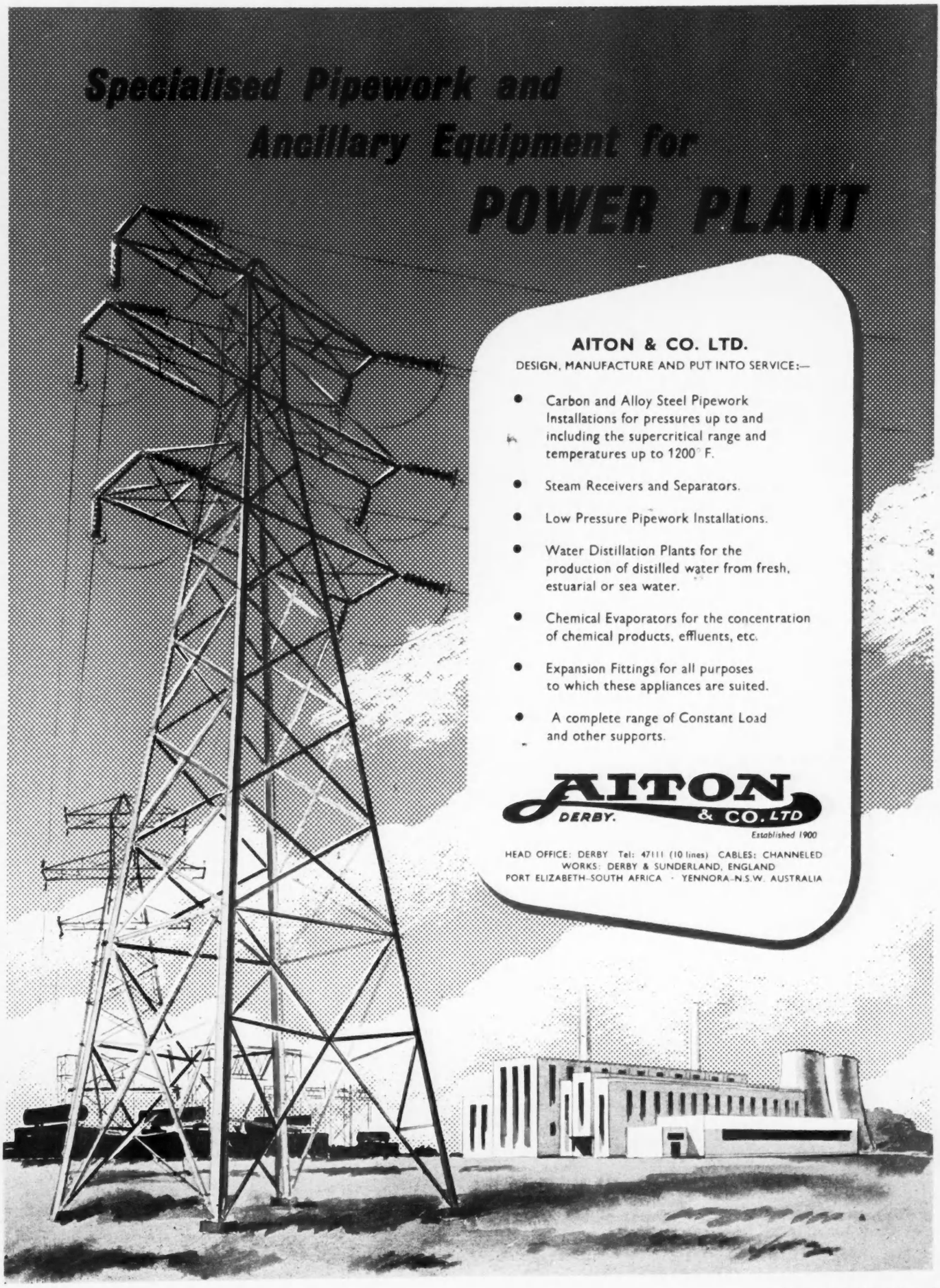

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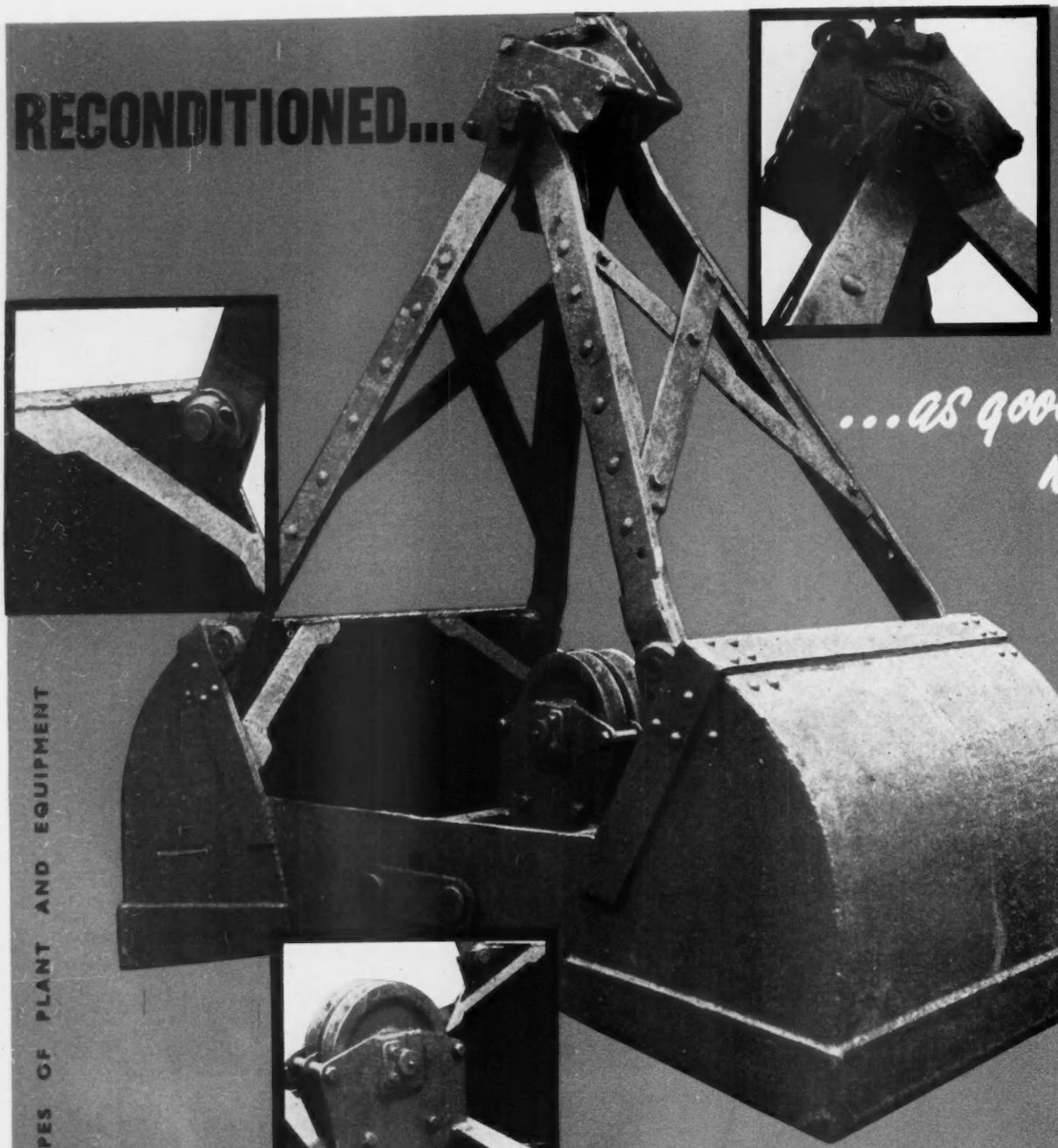

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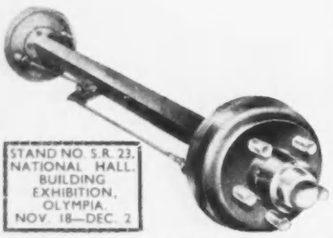

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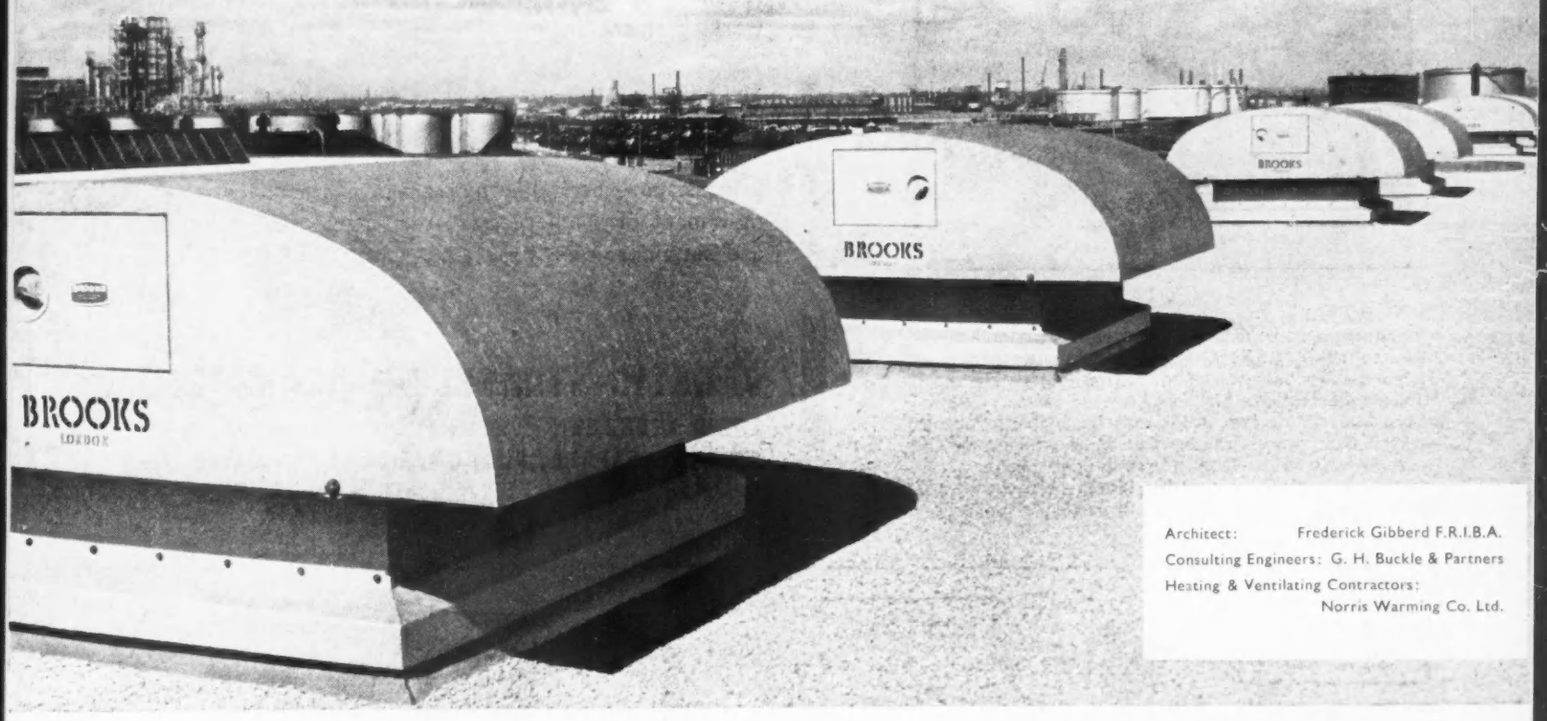

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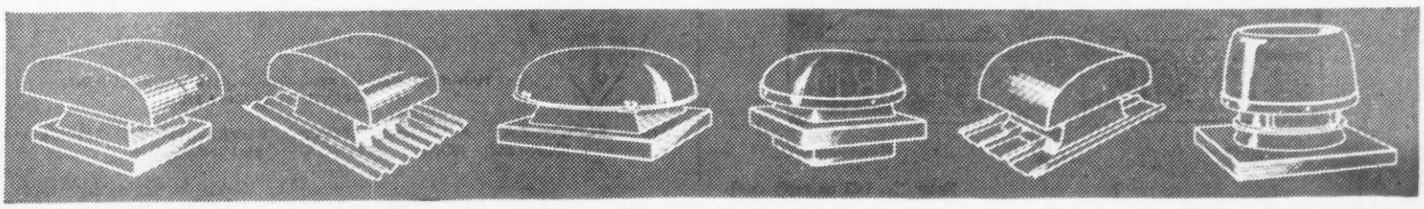

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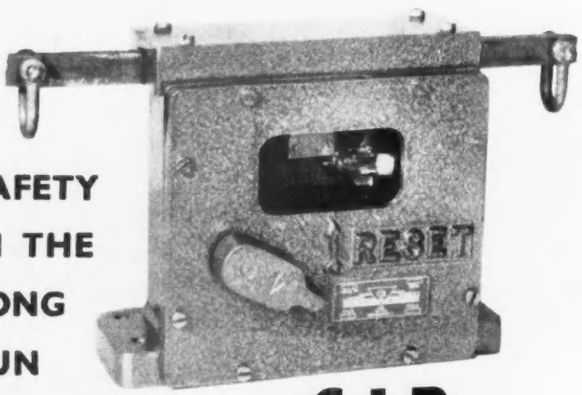

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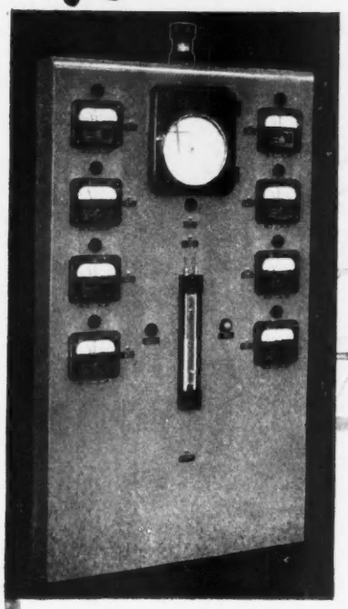

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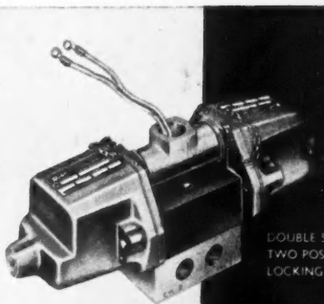

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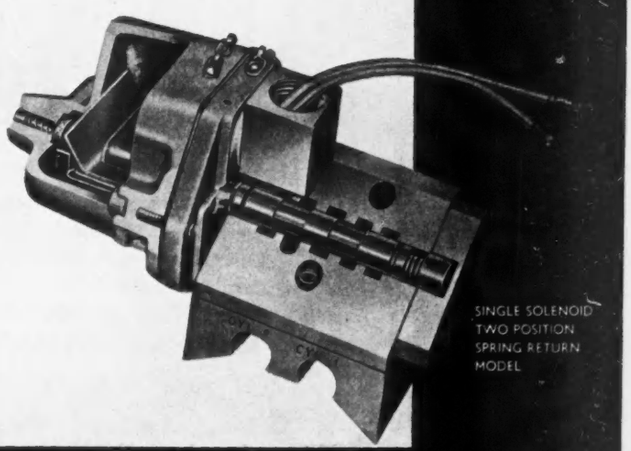

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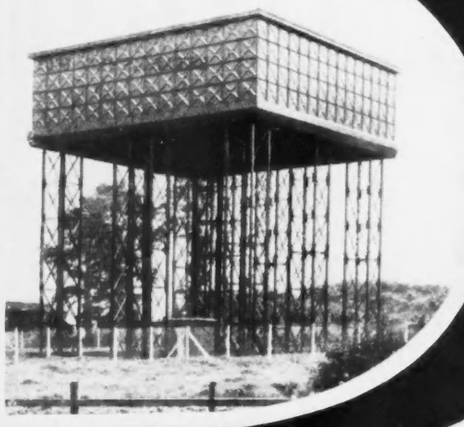

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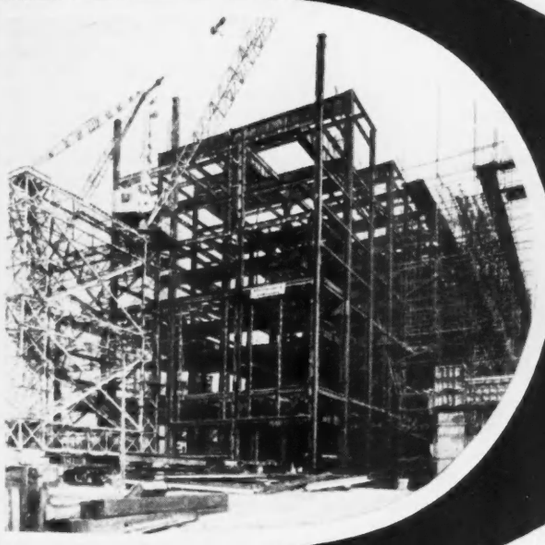

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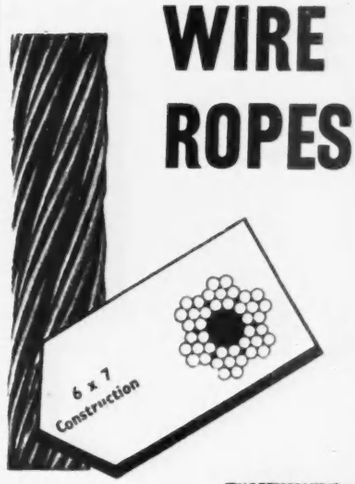

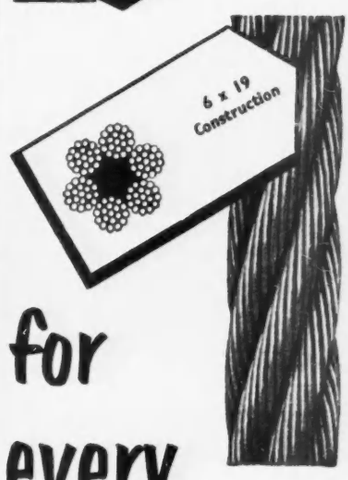

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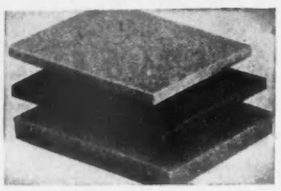

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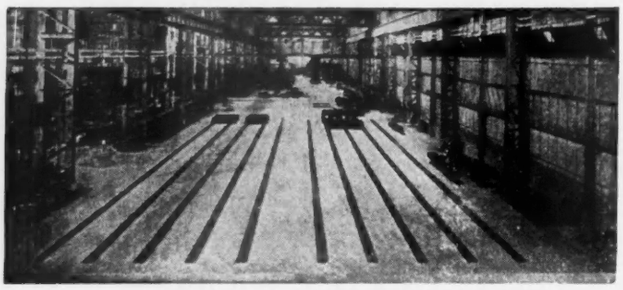

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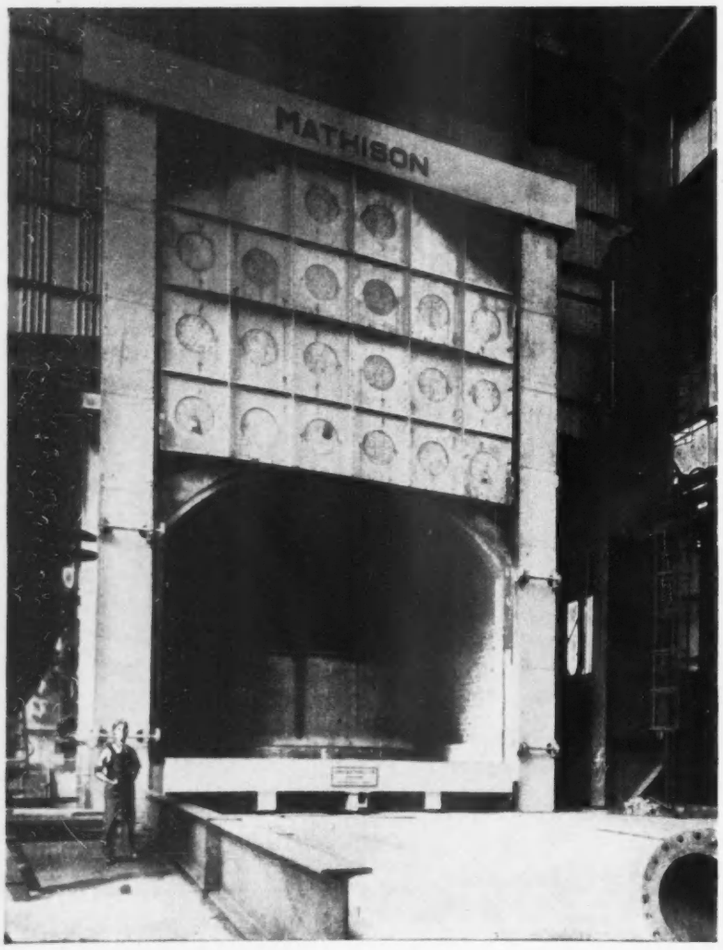

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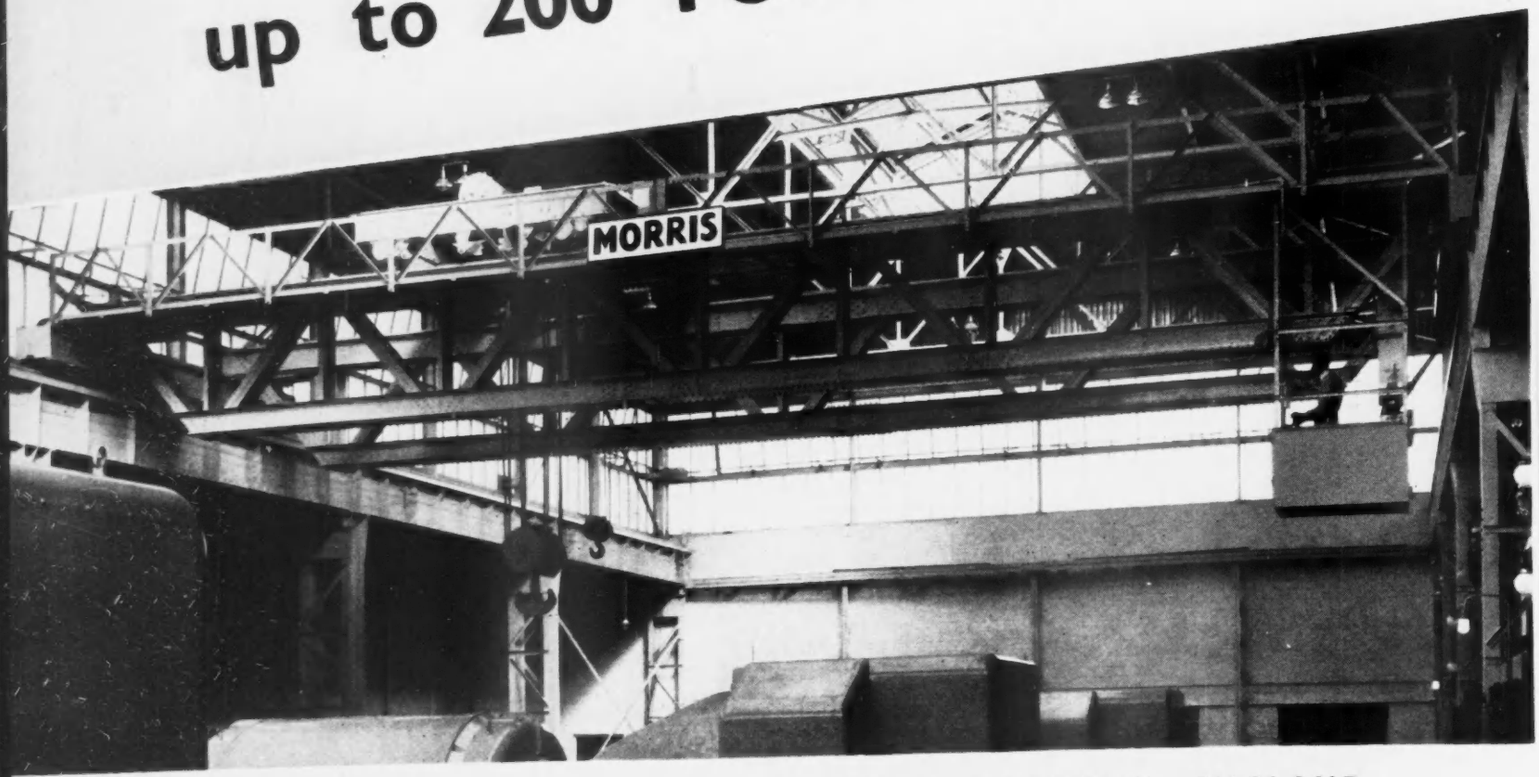

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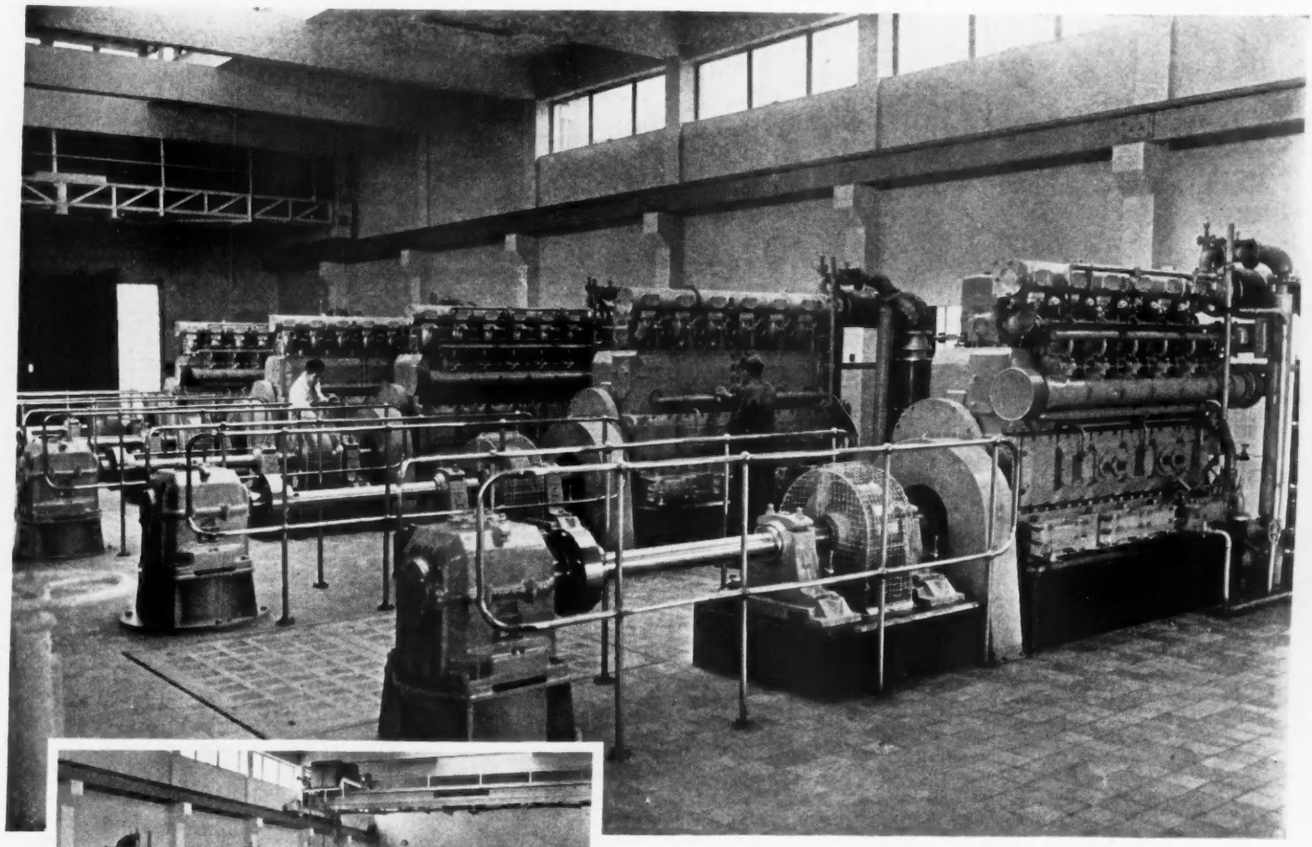

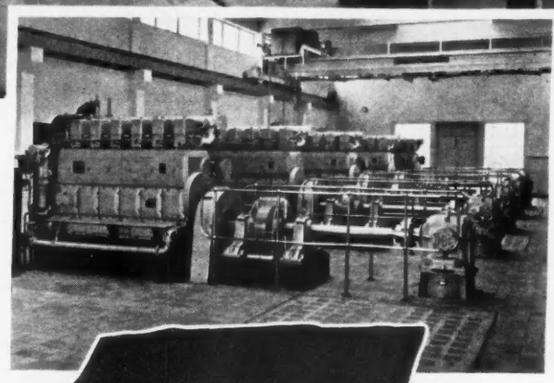

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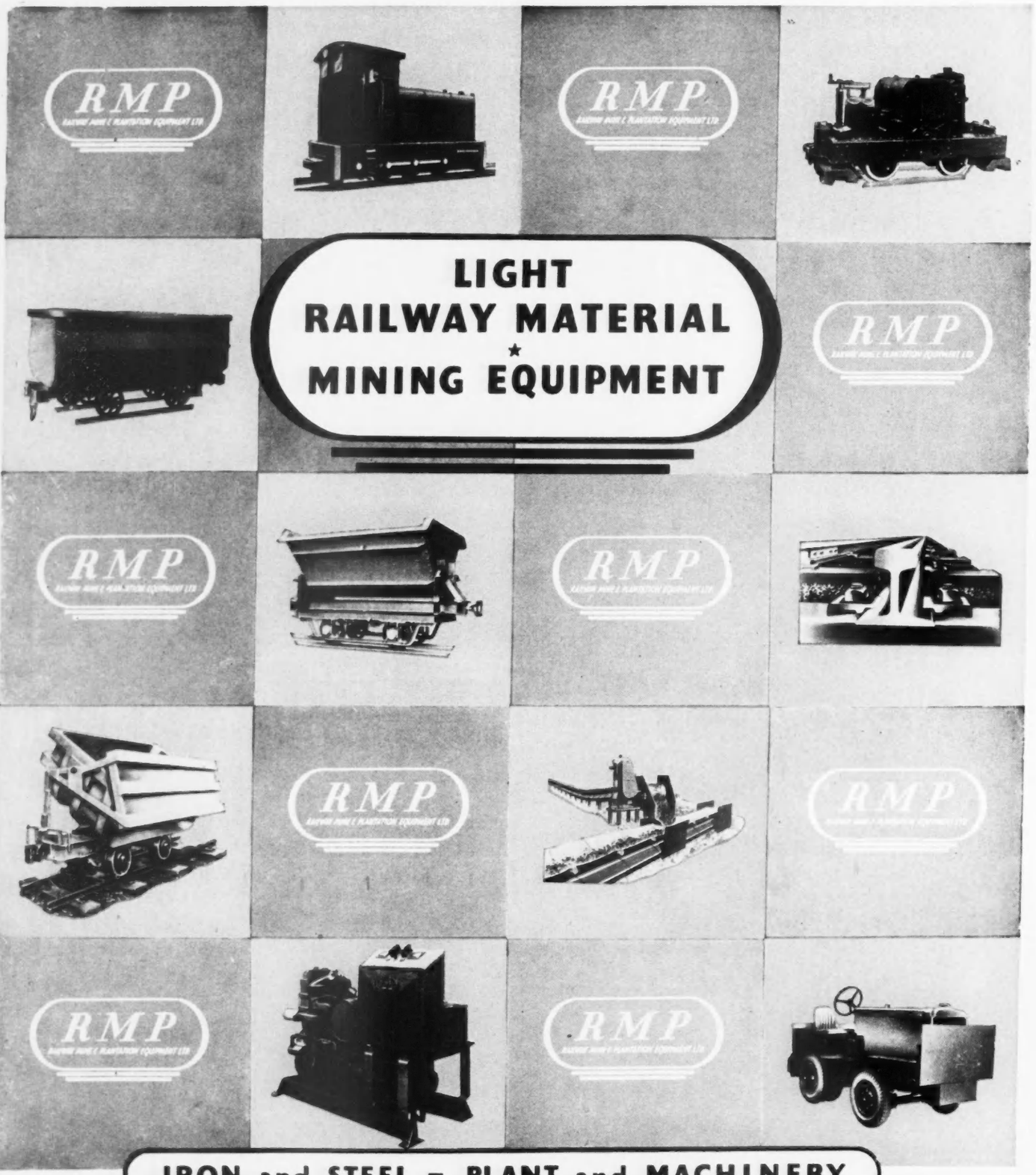

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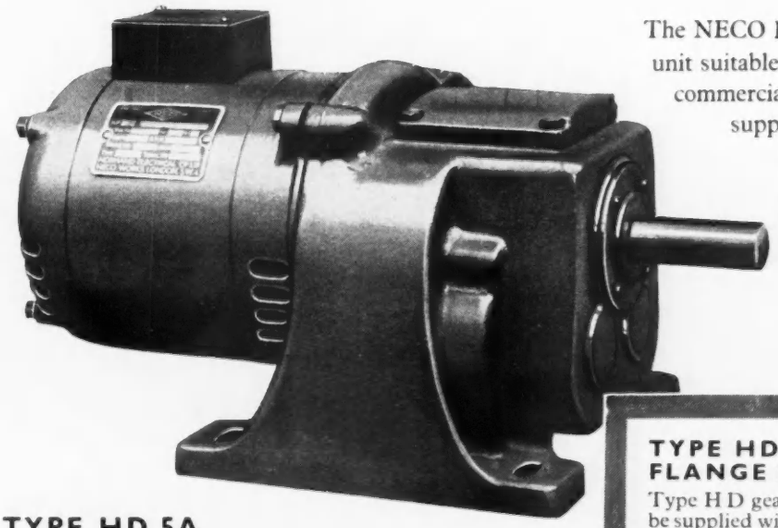

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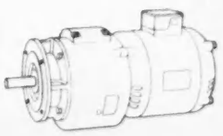

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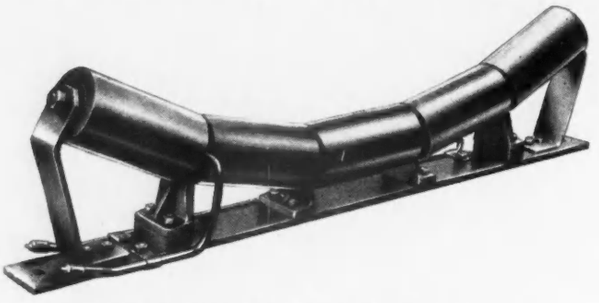

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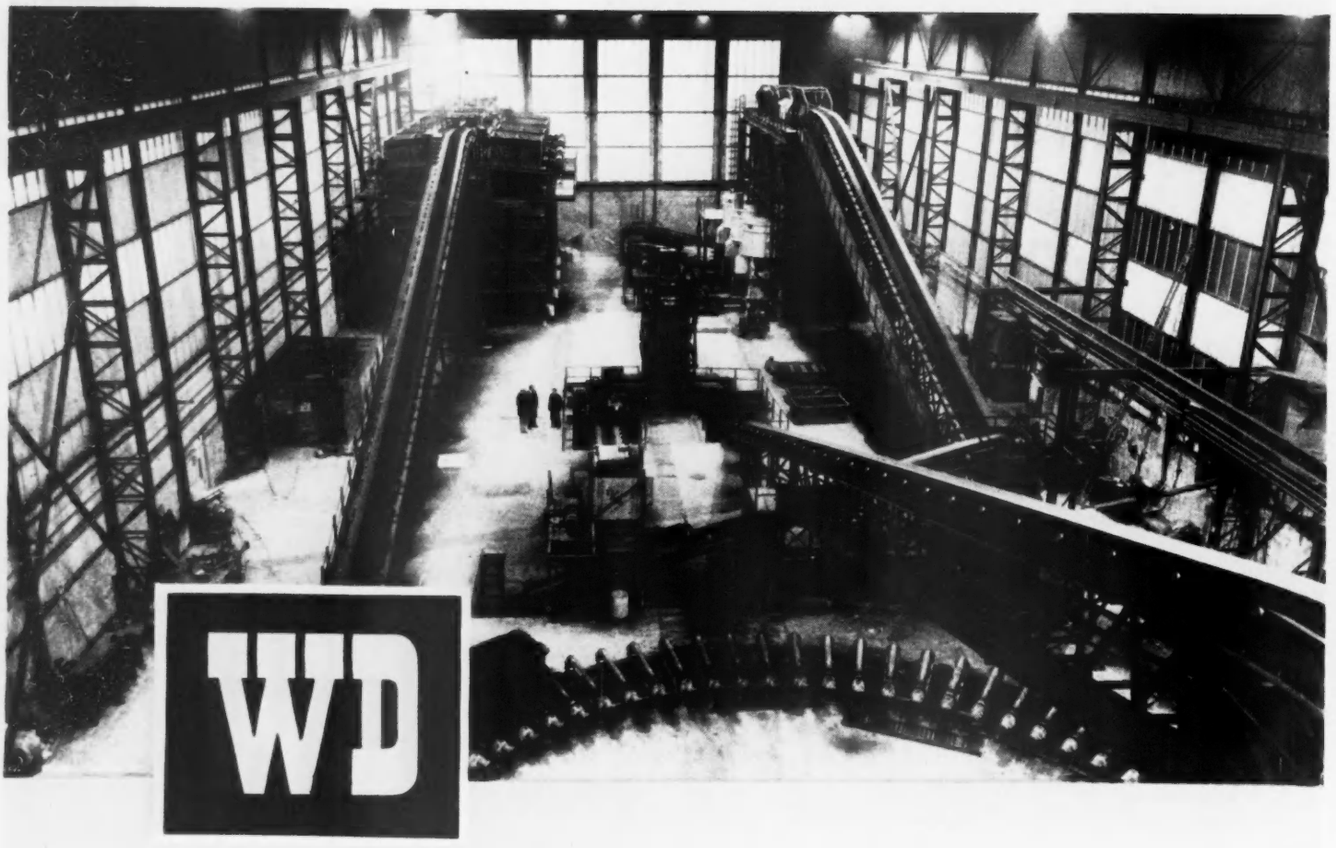

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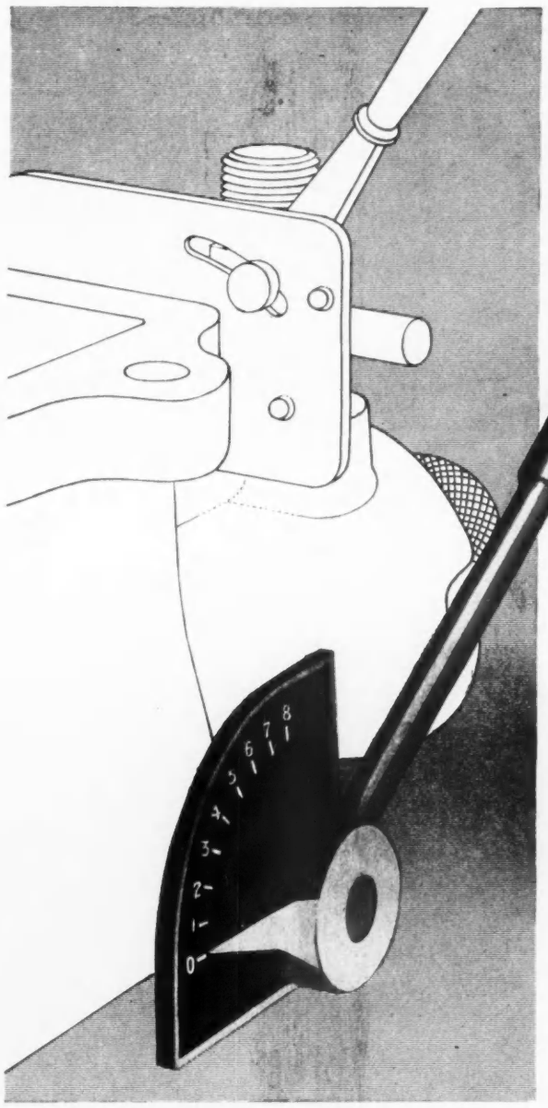

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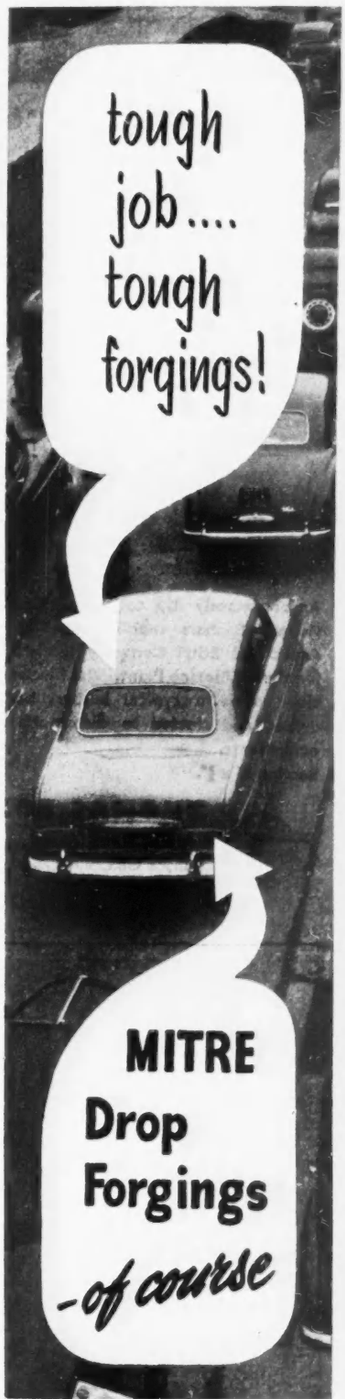

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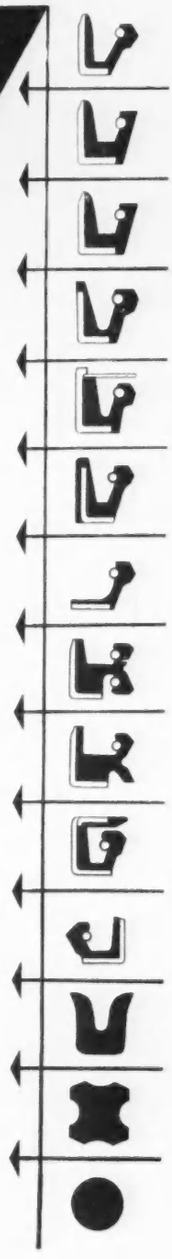

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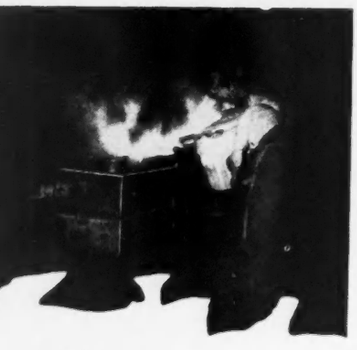

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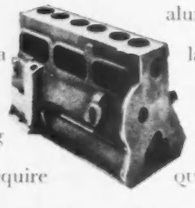

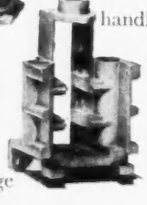

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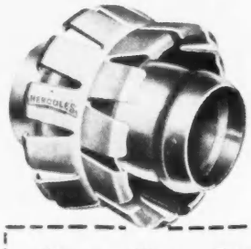

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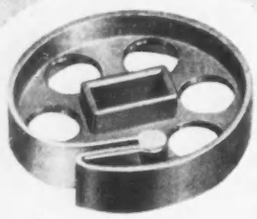

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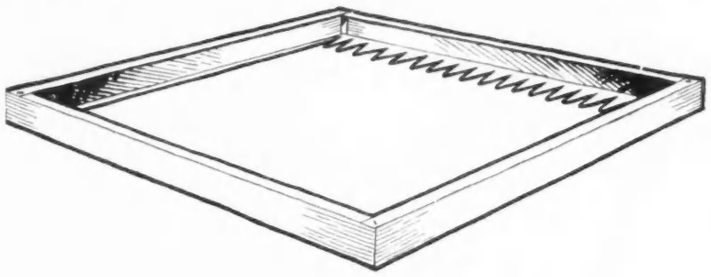

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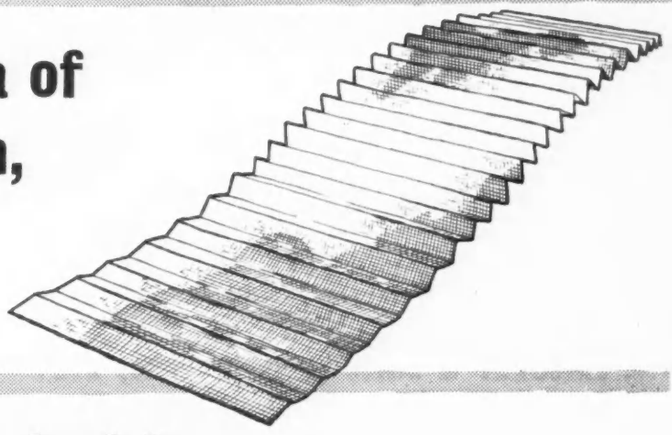

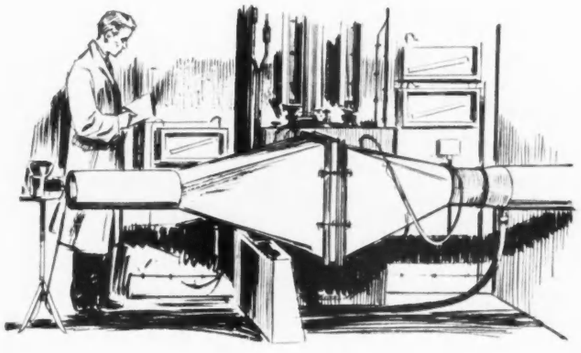

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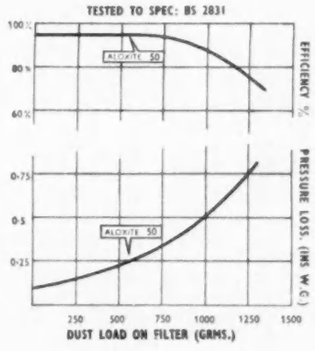

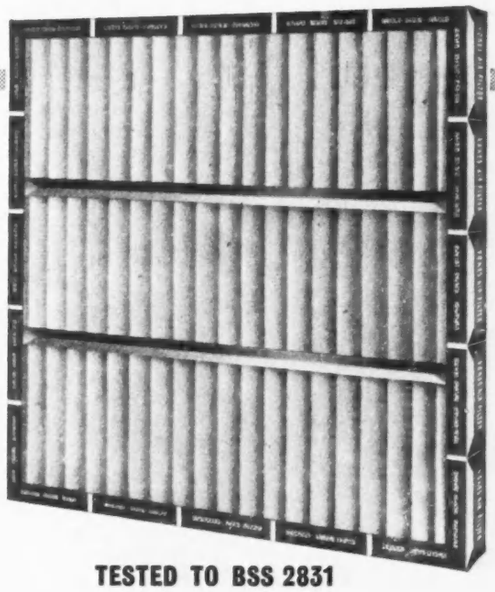

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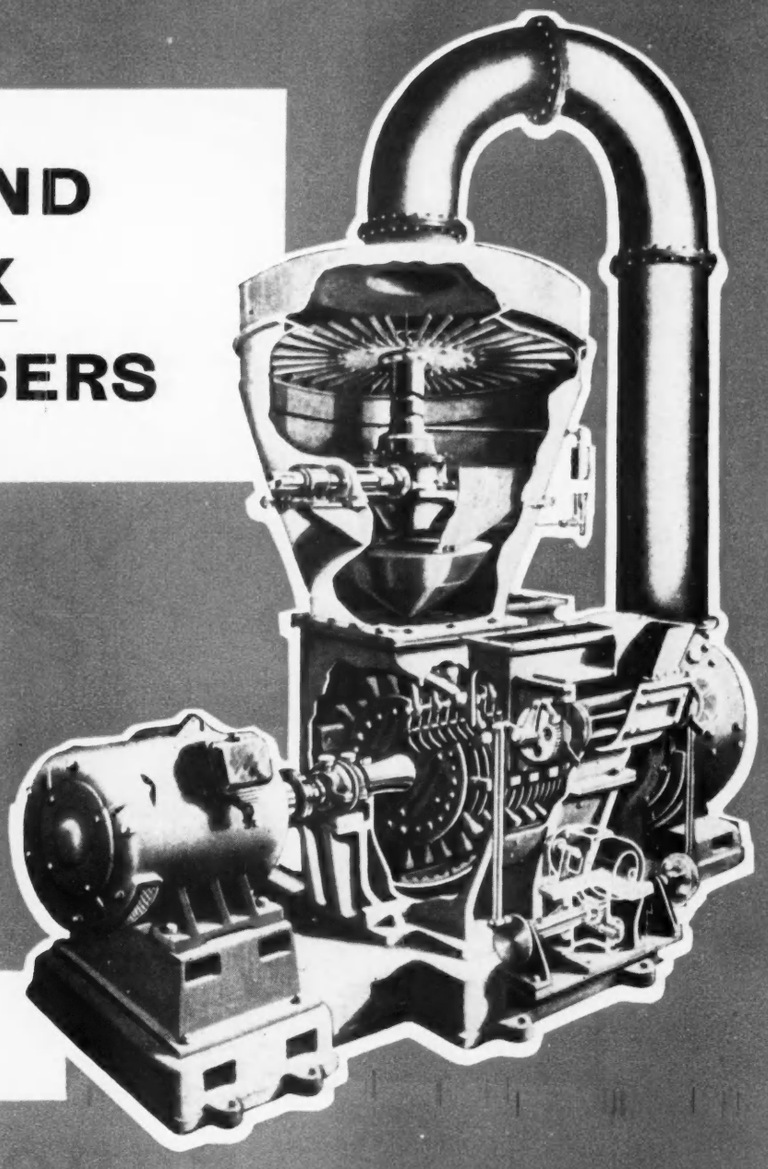

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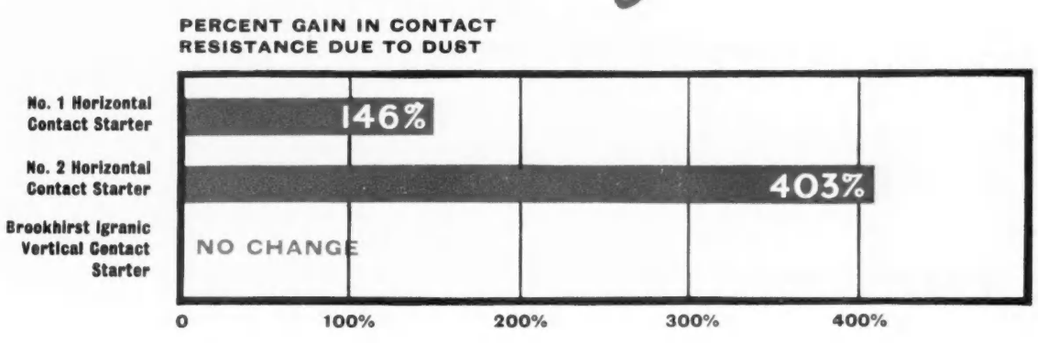

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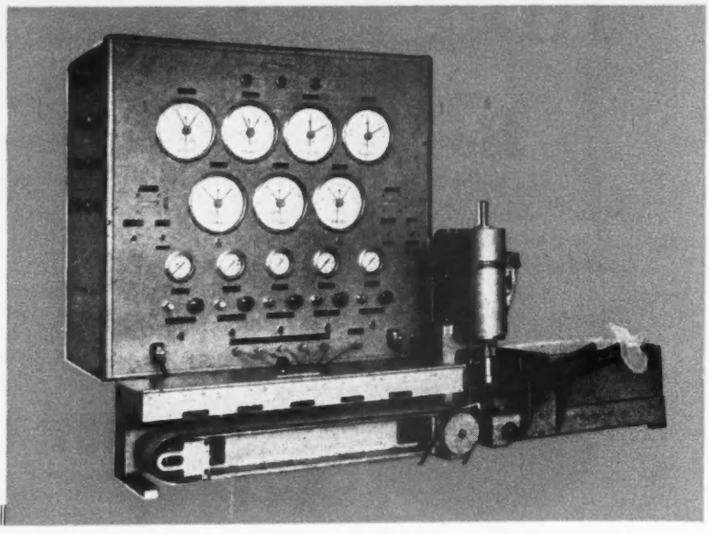

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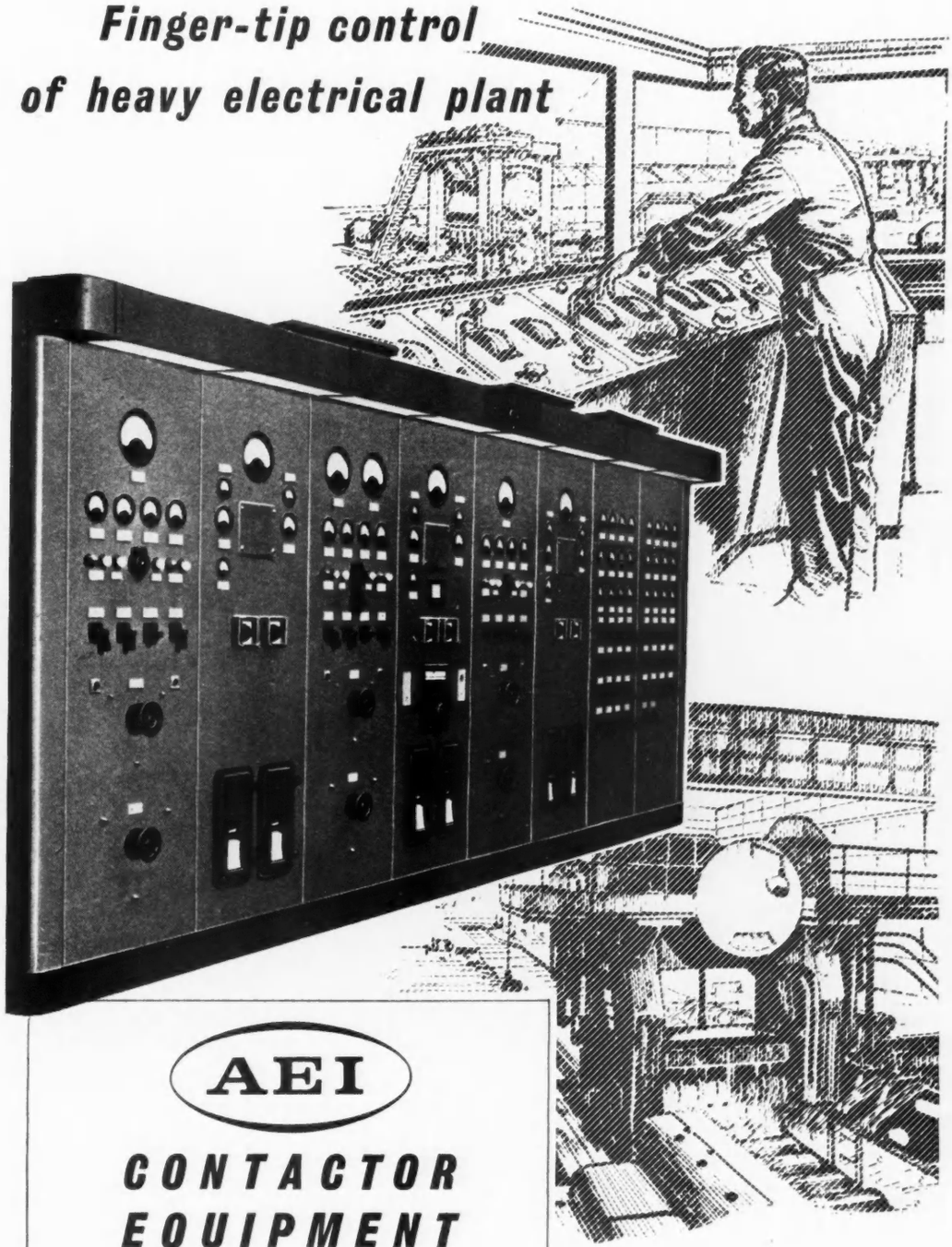

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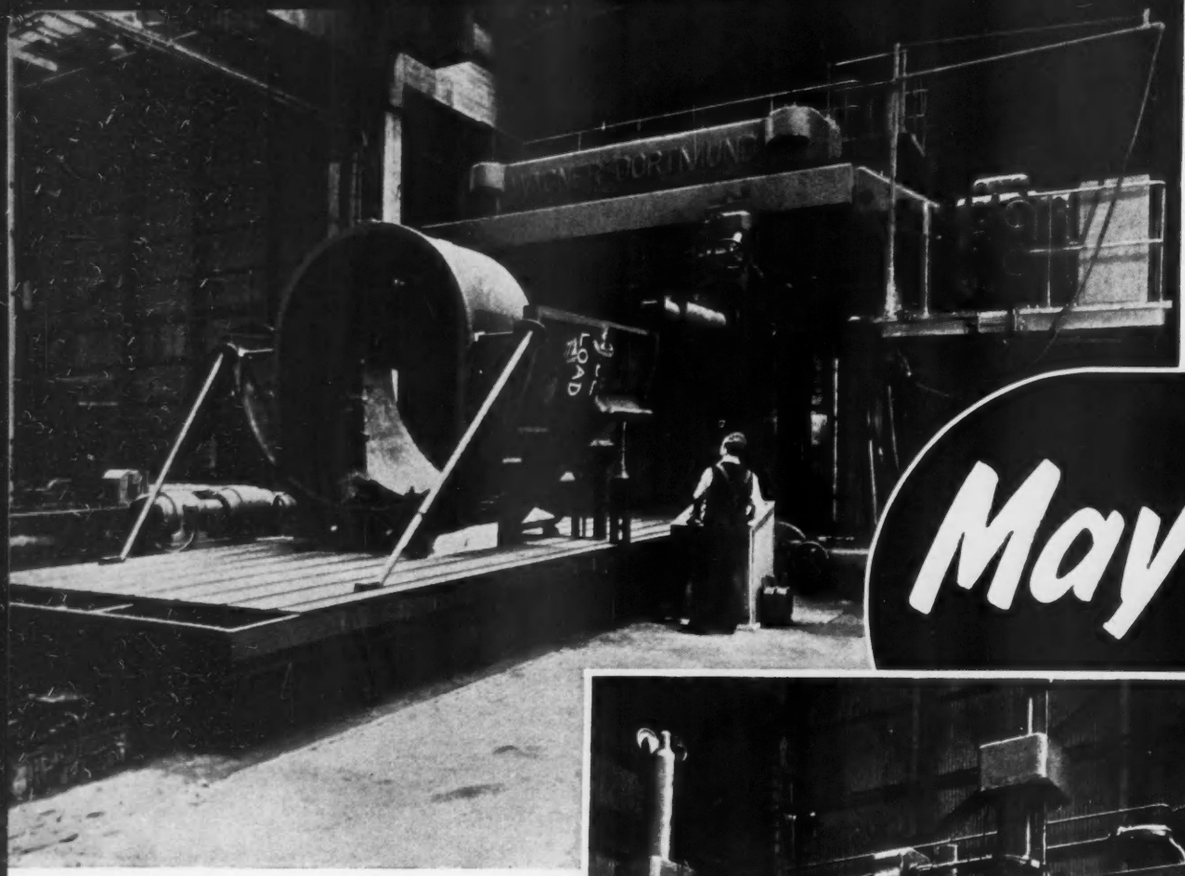

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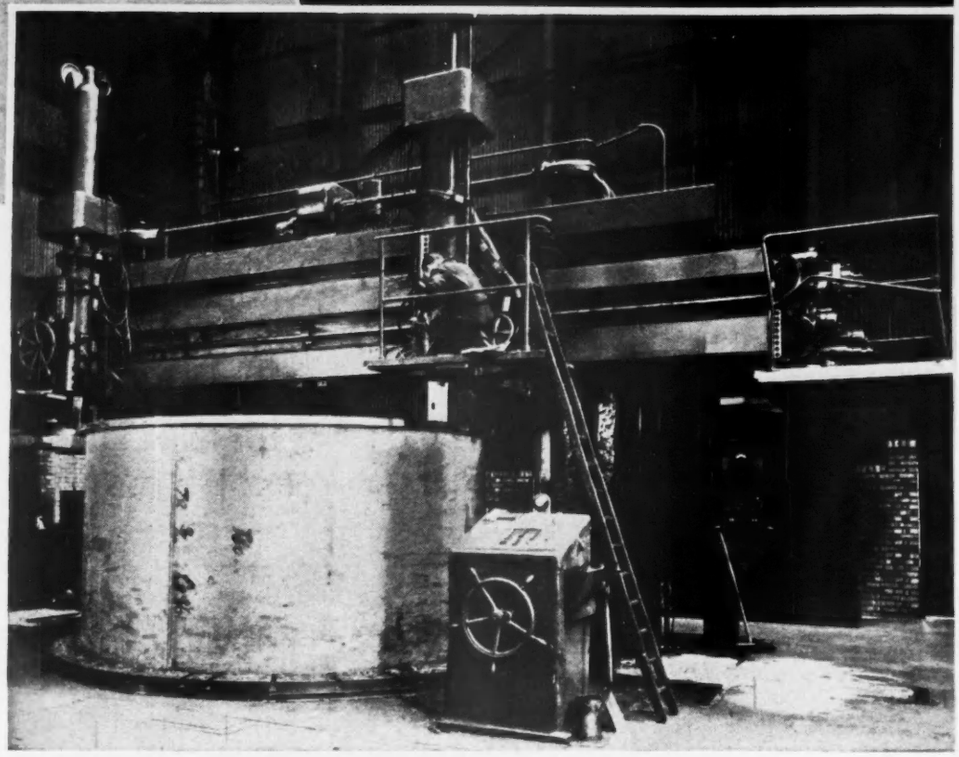

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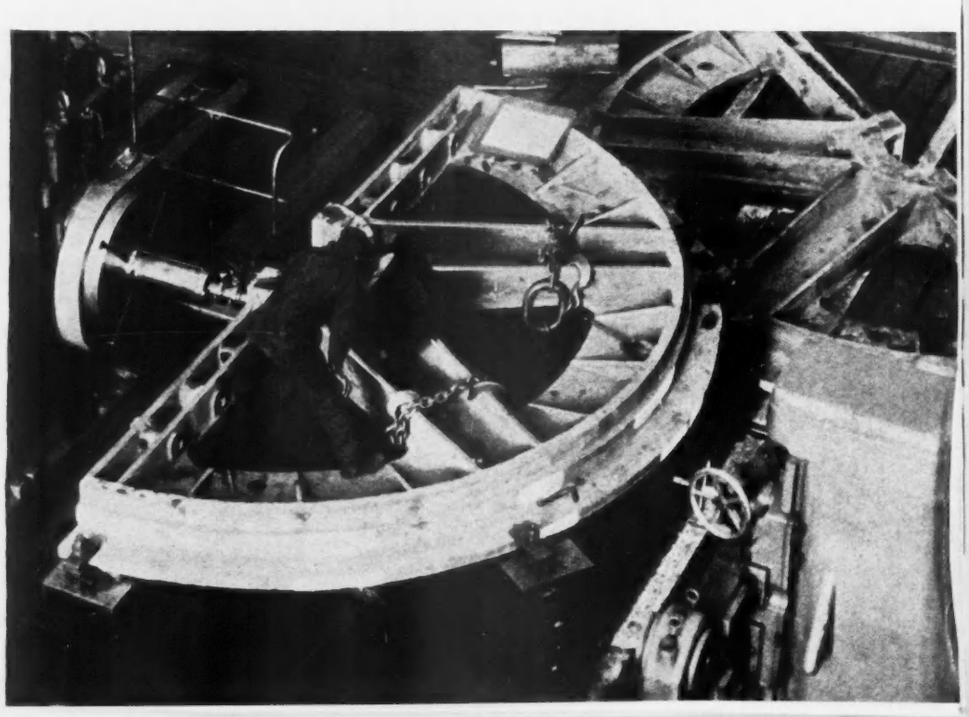

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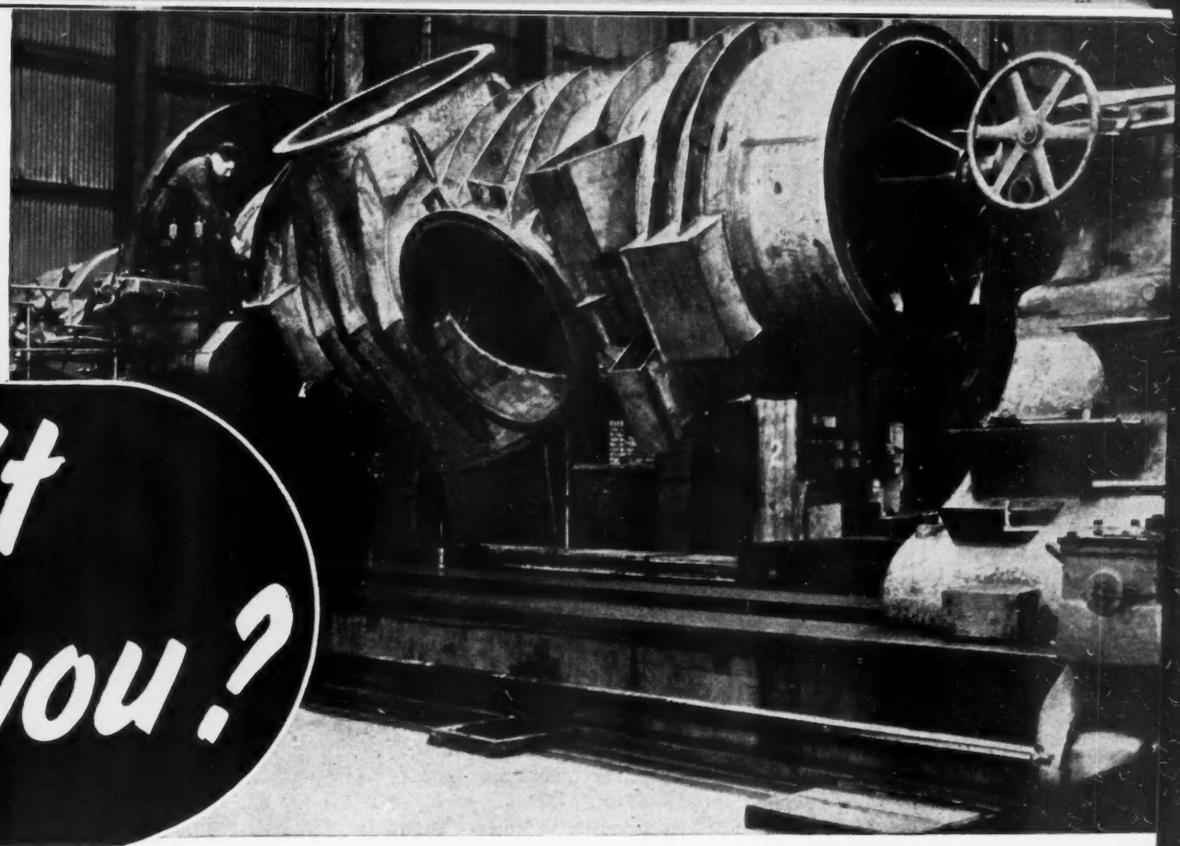

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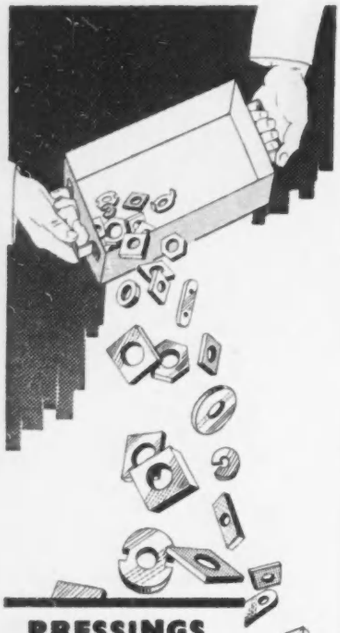

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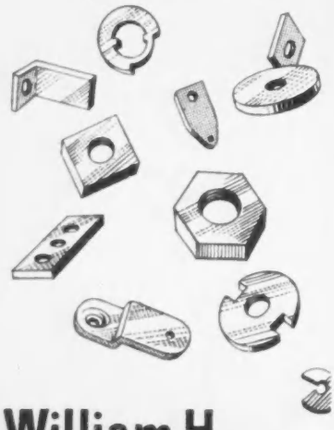

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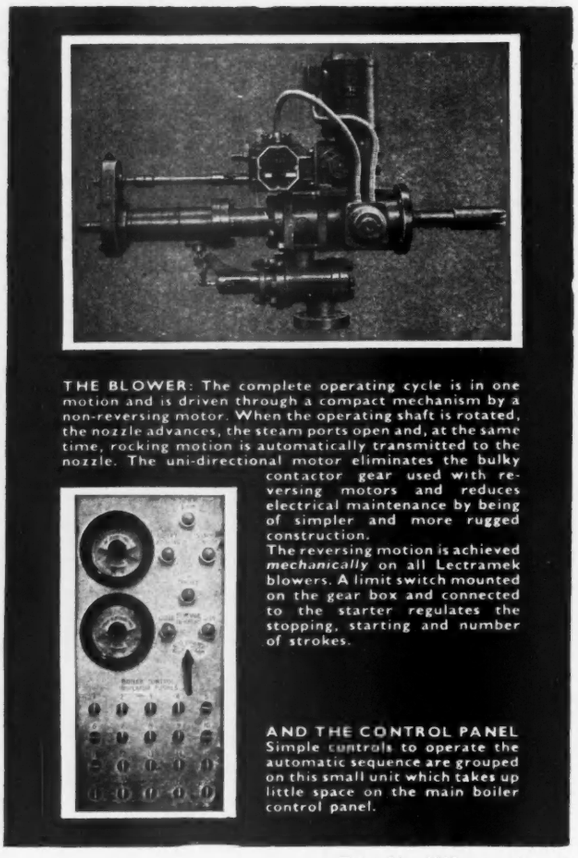

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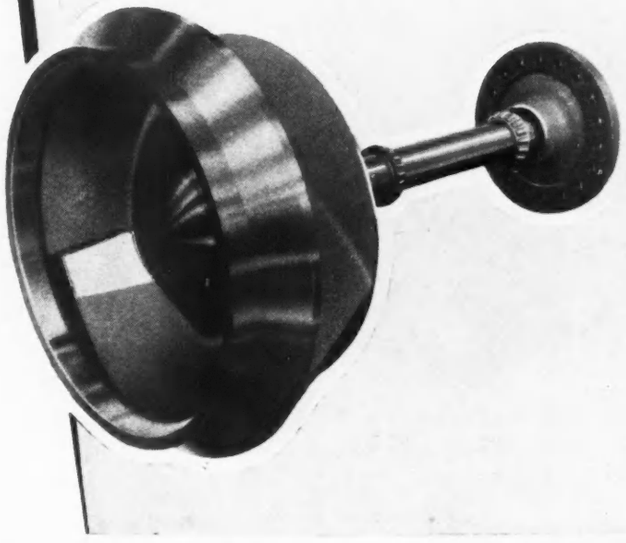

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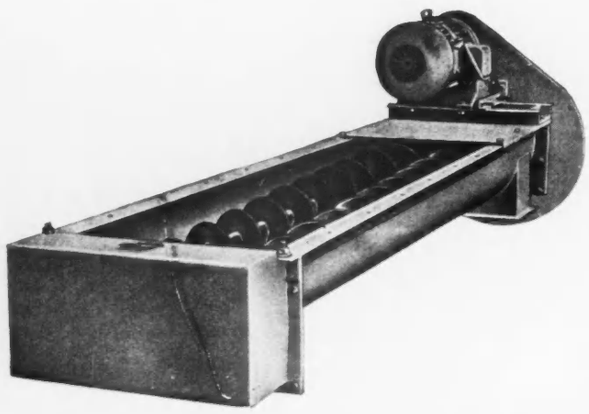

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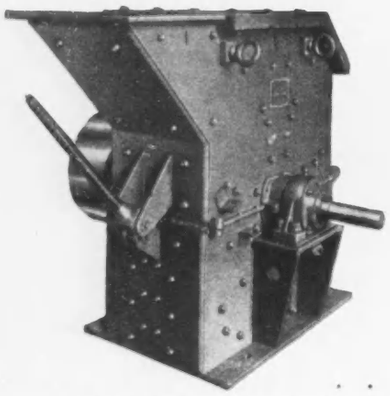

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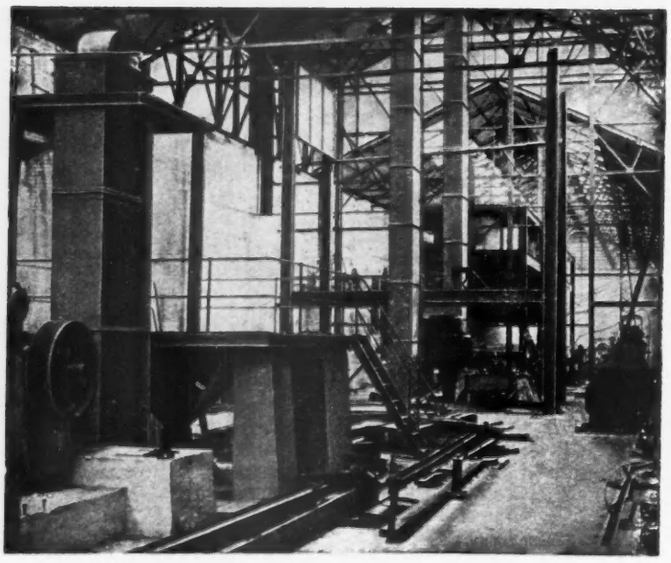

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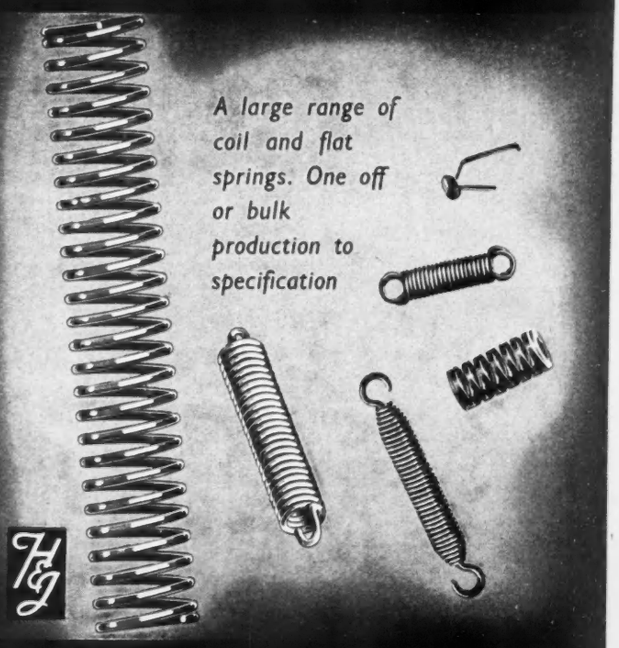

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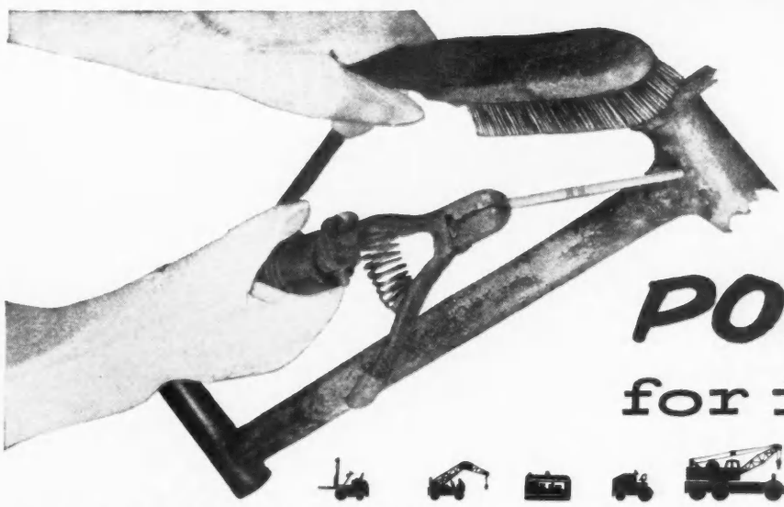

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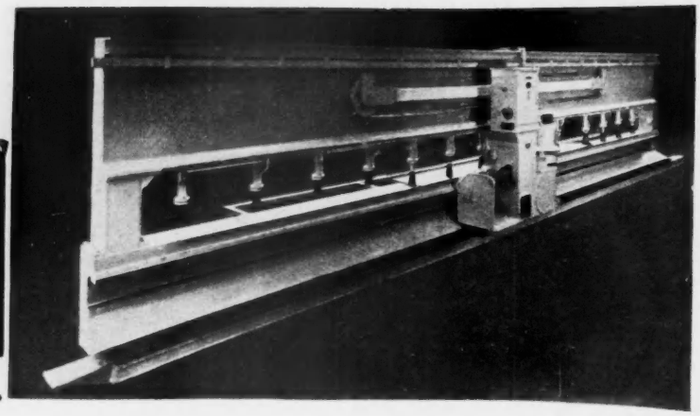
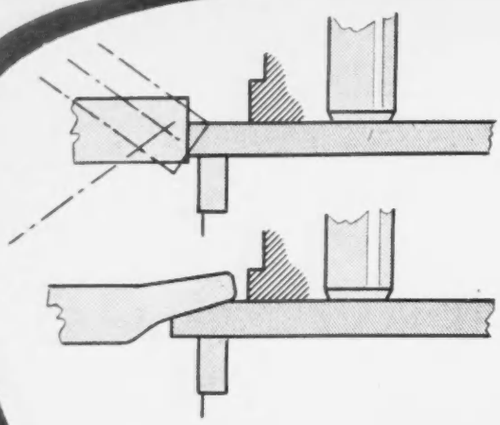
PLATE EDGE PLANING AND ROTARY SHEARING



JACK TYPE CLAMPING MACHINE



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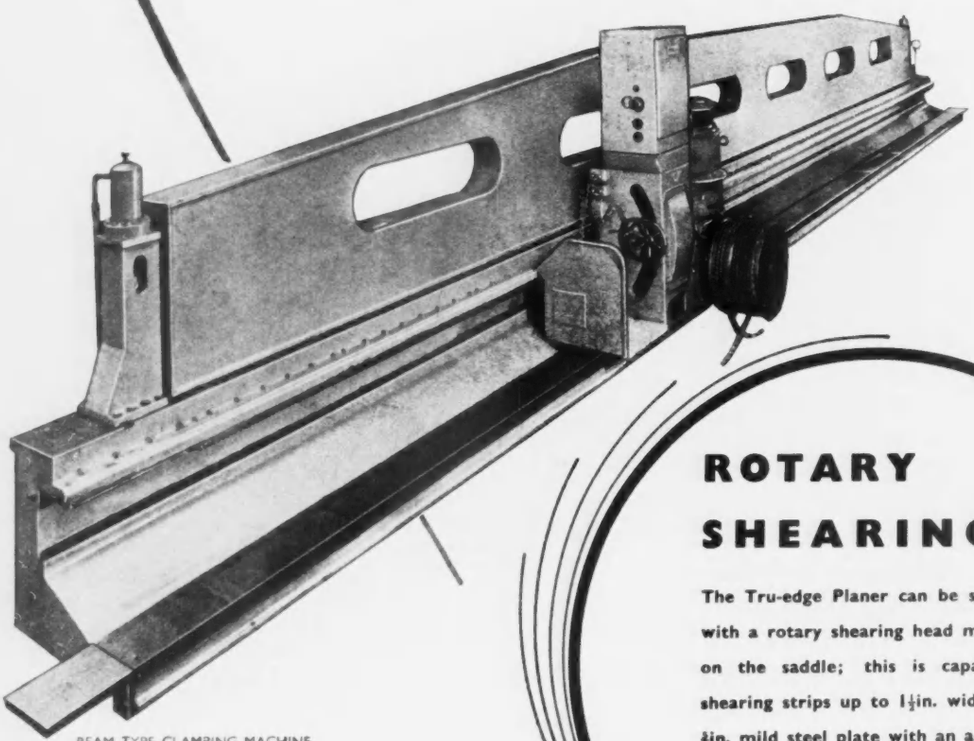
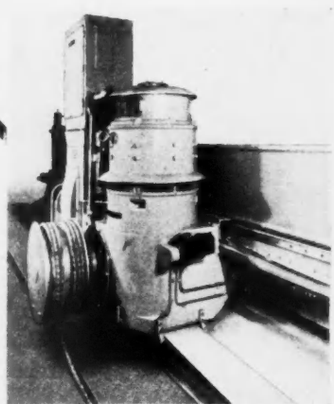
This planer, made in lengths of 25, 30, 35 and 40 feet, handles plates up to 2in. thick with speed and accuracy, and where thicker plates, or bundles of plates require edge planing we can provide a motorised tool box with a vertical rise of 6in. for progressive planing. Profile tools can be used in either case, or swivelling action can be provided for planing top and bottom bevels up to 35 deg. above or below the centre line. A special planing tool is available for cutting long bevels. In design and construction the Tru-edge Planer is highly modern in every respect and it will provide many years of excellent service. We will be pleased to supply technical information.



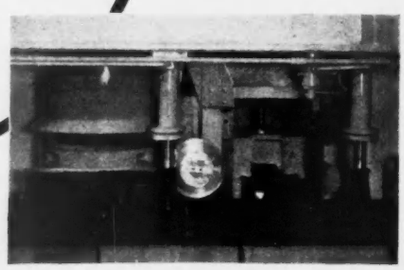
BEAM TYPE CLAMPING MACHINE

ROTARY SHEARING

The Tru-edge Planer can be supplied with a rotary shearing head mounted on the saddle; this is capable of shearing strips up to 1½in. wide from ¾in. mild steel plate with an accuracy of 0·01in. in 40 feet. Its operation is about forty times faster than gas cutting, and less expensive.



ROTARY SHEAR IN ACTION



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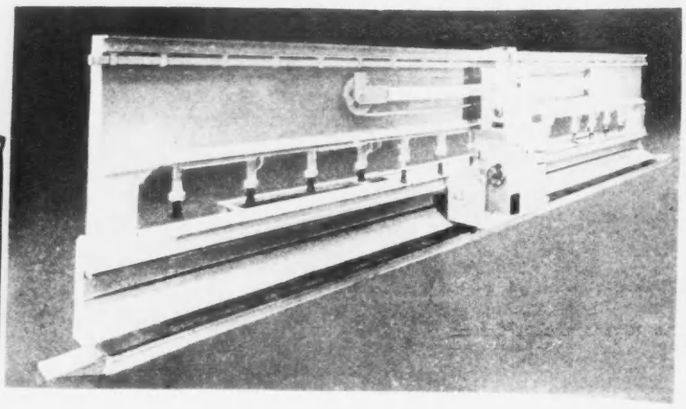

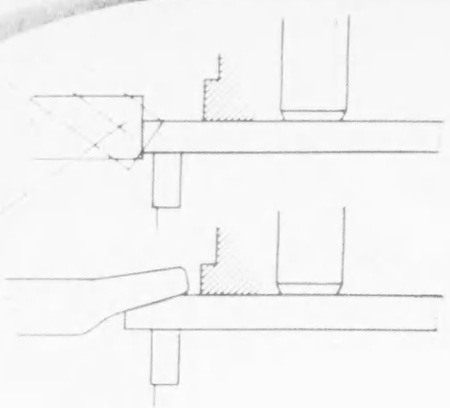

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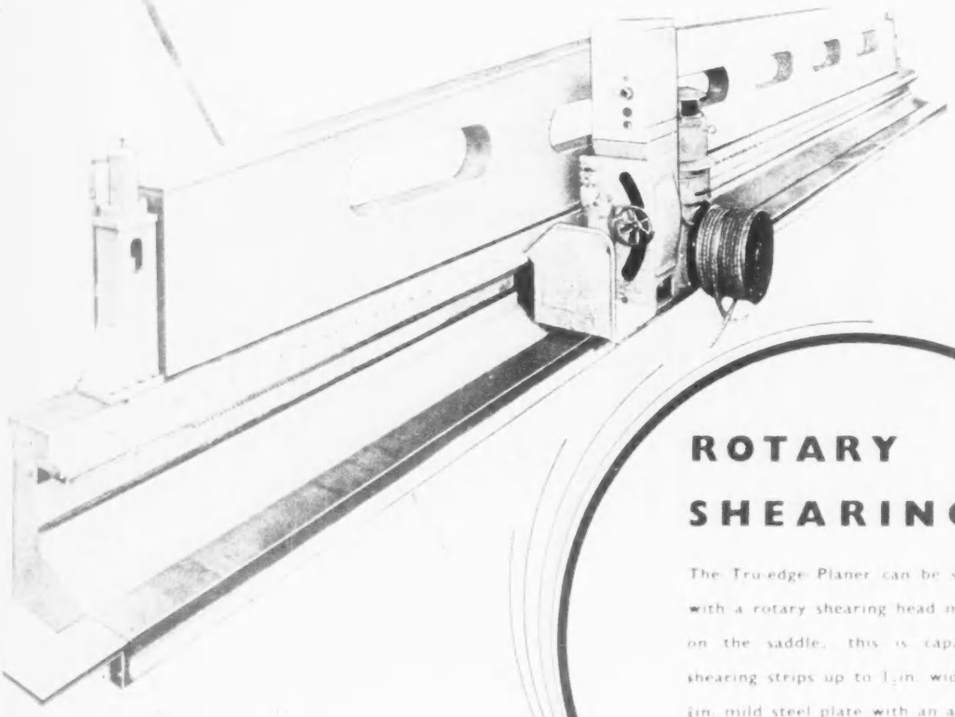

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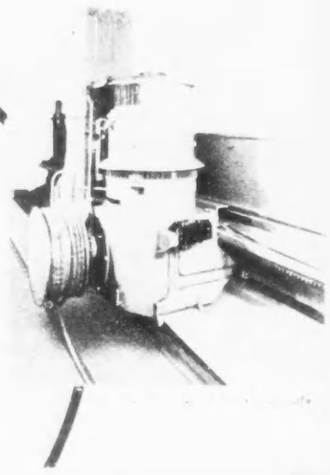

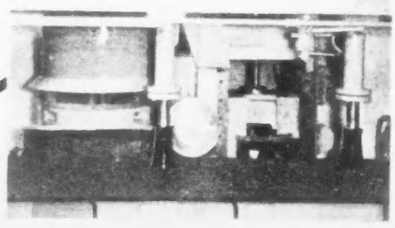

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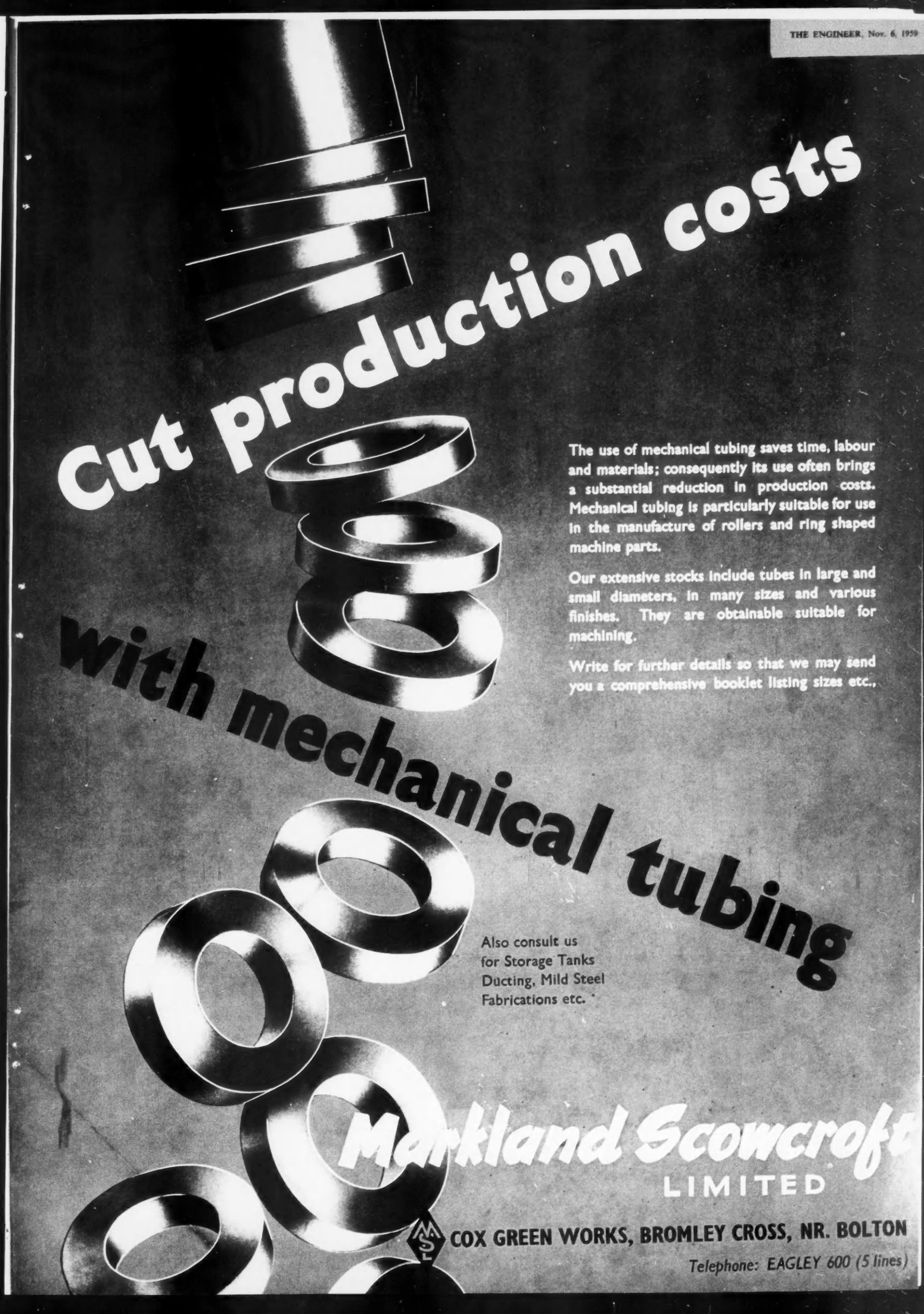

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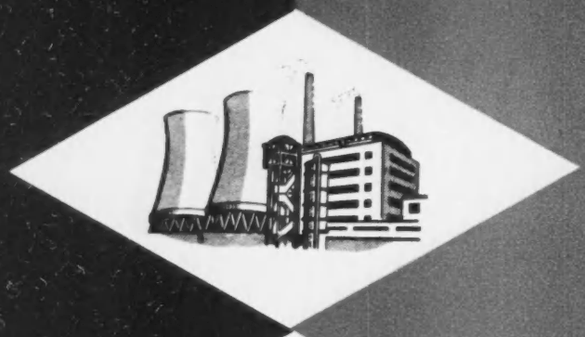

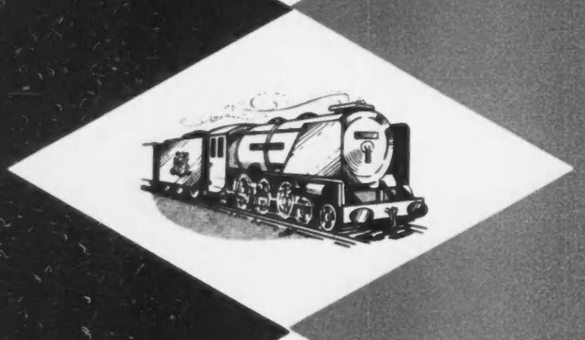

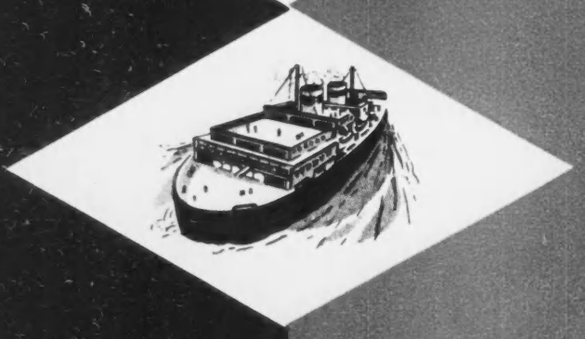

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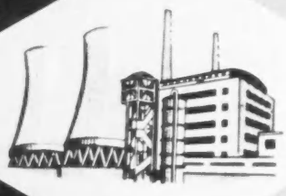

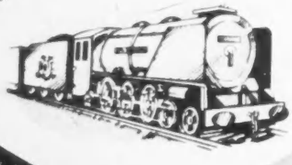

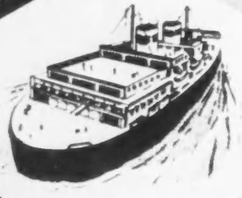

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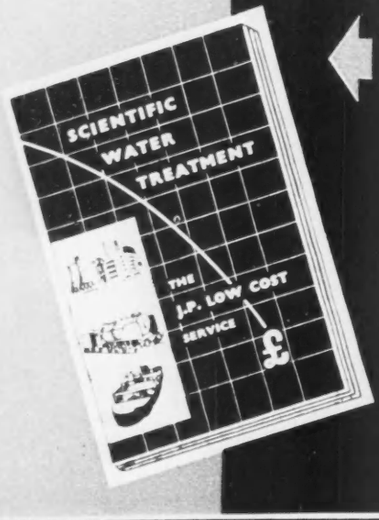

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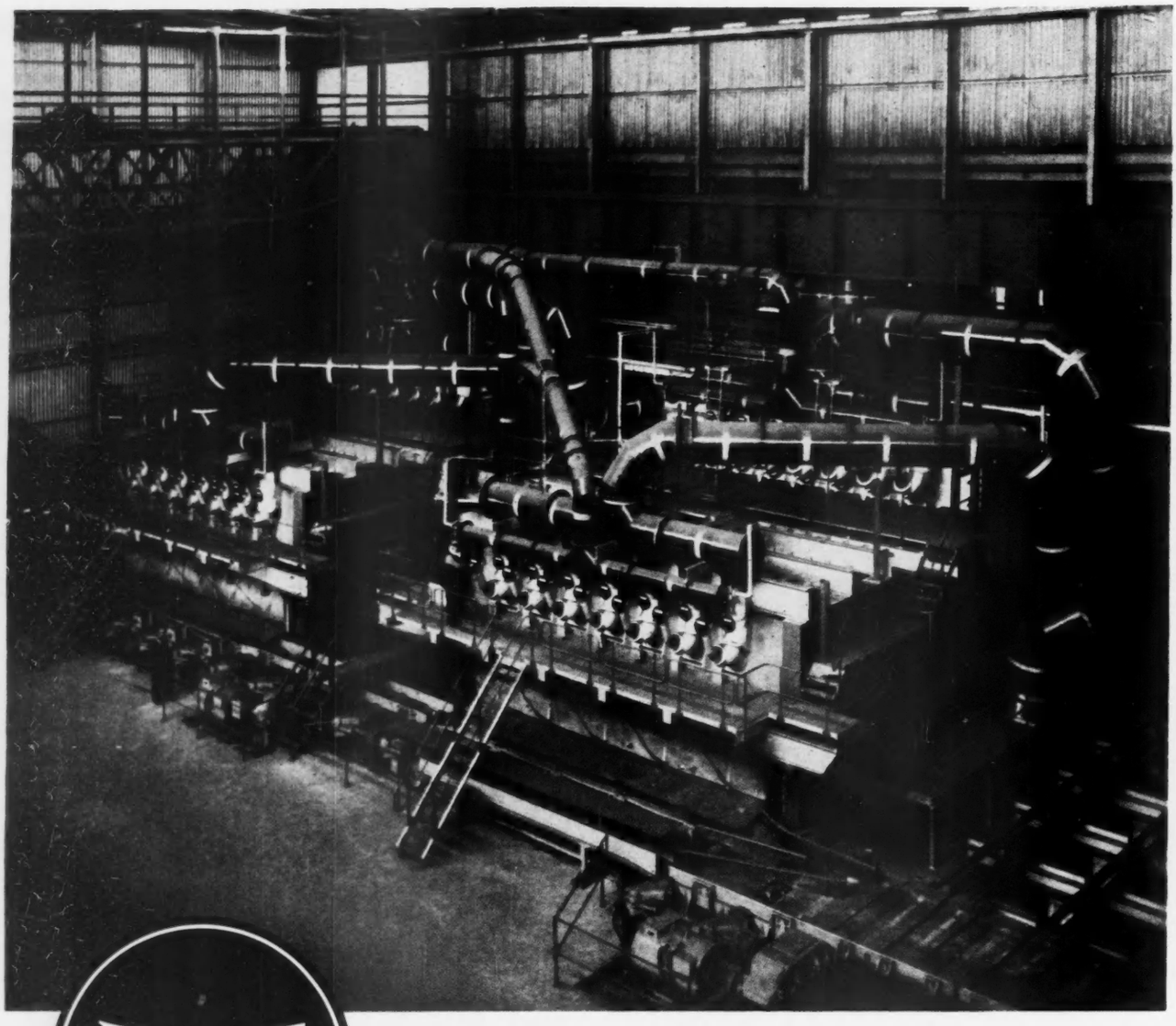

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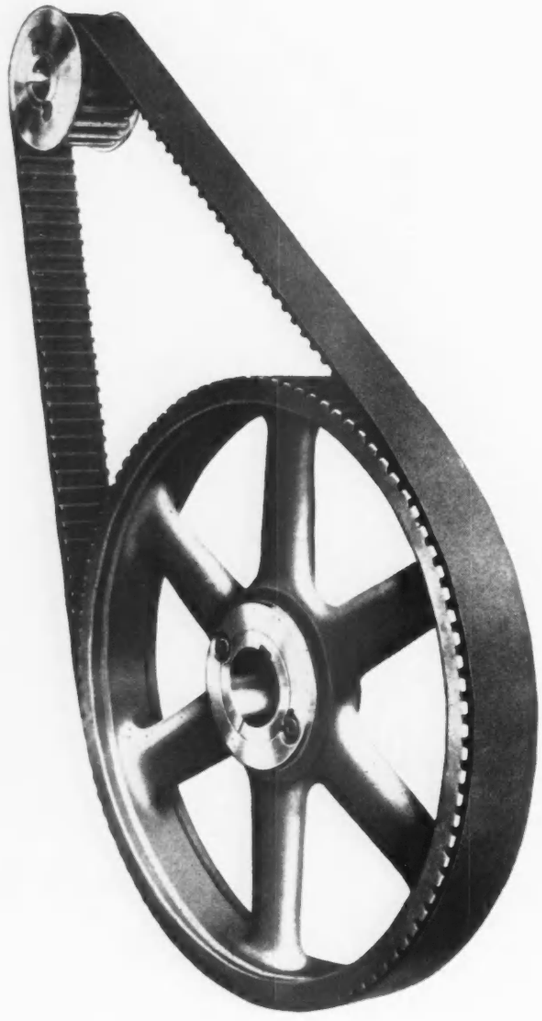

POWERGRIP
TIMING BELT DRIVES

Send for Publication 5927/K

Crofts (Engineers) Limited, Thornbury, Bradford 3, Yorkshire

POWERGRIP

TIMING BELT DRIVES ARE AVAILABLE EX-STOCK FROM CROFTS

THE BELT DRIVE WITH GEAR TRAIN PRECISION

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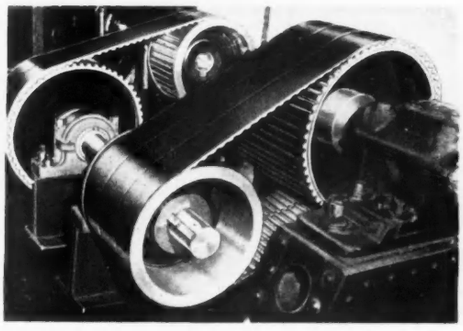
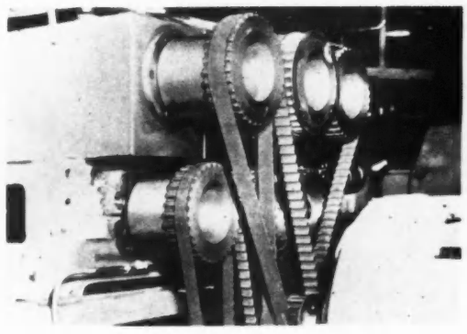


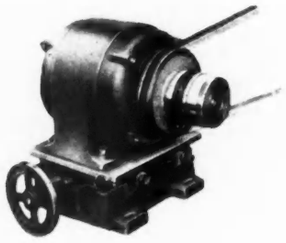
PowerGrip Timing Belts as an increasing gear on a dredge pump.



PowerGrip Timing Belts operating a multiple drive.

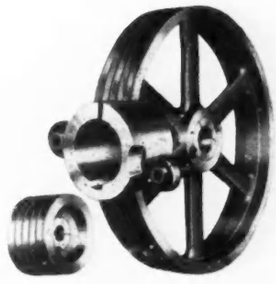
PowerGrip drives up to 64 h.p. supplied from stock; up to 1000 h.p. available on order

ALSO:



Variable Speed Pulleys
automatic and stationary adjustment types; up to 80 h.p.; ratios up to 15 : 1
(Publication 353 K)

Flat Belt Pulleys
for every class of drive—cast iron, wrought iron or fabricated steel



Crofts V-Rope Pulleys
parallel bored (Publications 5762 K & 5763 K)
or fitted with Crofts Patent Taper-Flushbush (Publications 5761 K & 5763 K)

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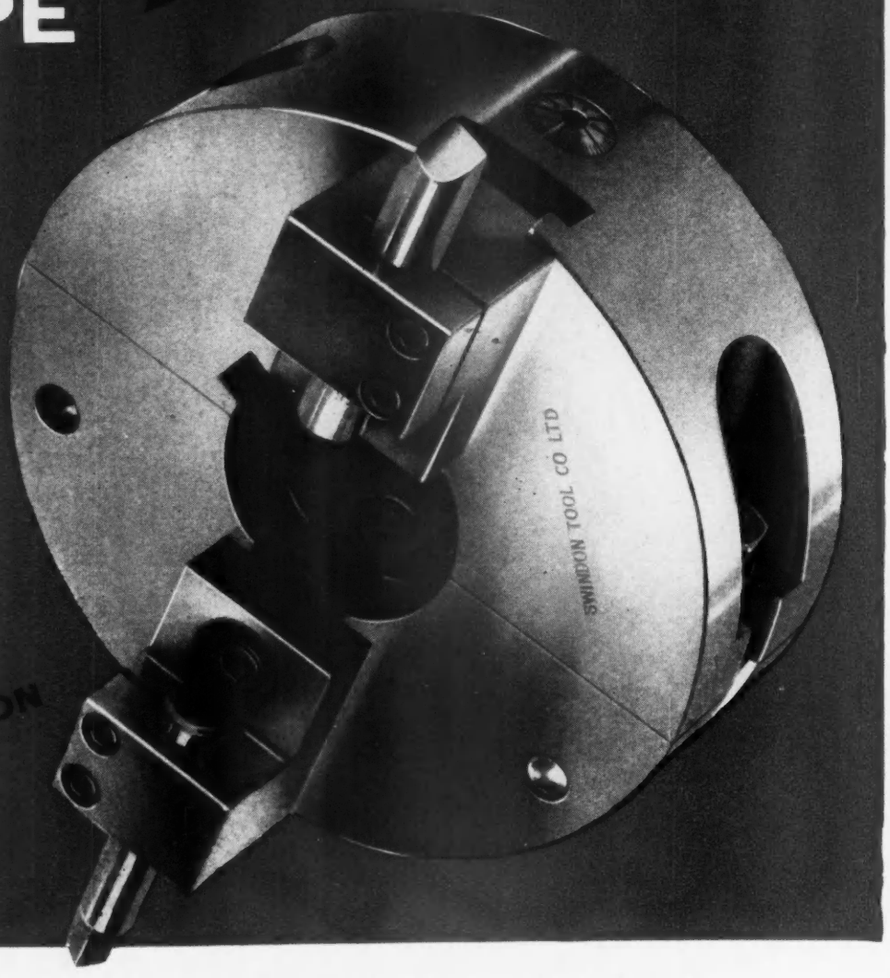
THE NEW BAR TYPE BORING HEAD

MICRO ADJUSTMENT

RIGID CLAMPING

TROUBLE FREE OPERATION



Here is the latest addition to the Swintool range of precision machine tools, the new Bar Type Boring Head, with micrometer adjustment. The illustration clearly demonstrates the simplicity of adjustment, plus rigid clamping, which are features exclusive to this new machine tool. Full details and specification will be sent on request.

SWINTOOL

World patents applied for

BAR TYPE BORING HEAD

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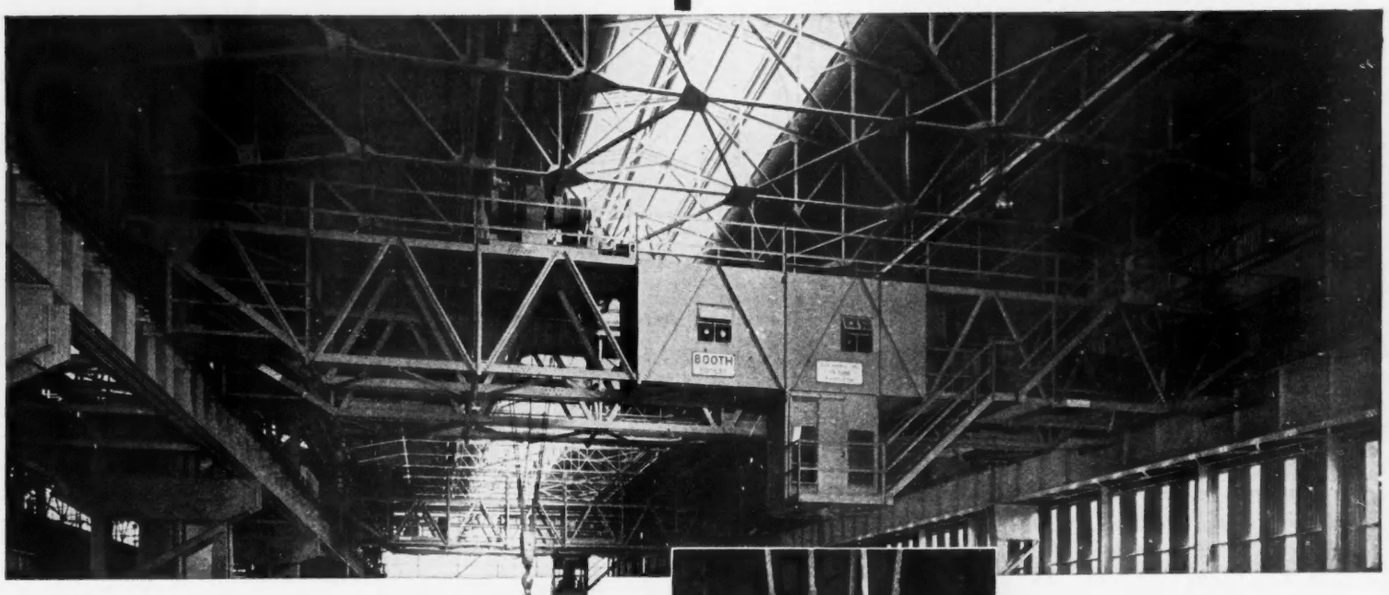
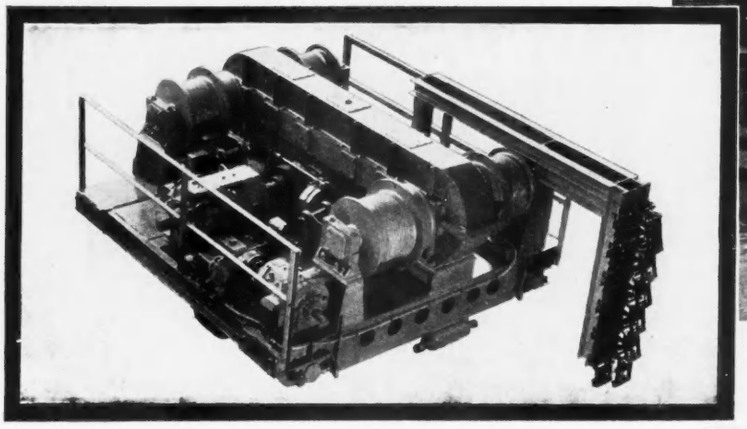
CLYDE-BOOTH

CONTINUOUS PROCESS CRANES FOR STEELWORKS ETC.



(ABOVE) Clyde-Booth four point suspension electric overhead travelling magnet crane at Messrs. Colvilles Ltd., Ravenscraig Works.
(RIGHT) The hook with slip-ring gear for the magnet, showing attachment of the four ropes.
(BELOW) The special four barrel crab.



With the introduction of higher rates of acceleraton and braking on traversing and long travel motions, in order to get the maximum output from overhead travelling cranes, magnet cranes with multiple splayed ropes are finding favour.

This type of suspension effectively damps out swinging of the load due to acceleration and braking forces.

Clyde-Booth cranes of three and four rope suspension design are produced to meet these requirements.

Our publication "The Booth Handbook on Overhead Cranes" is available on request.

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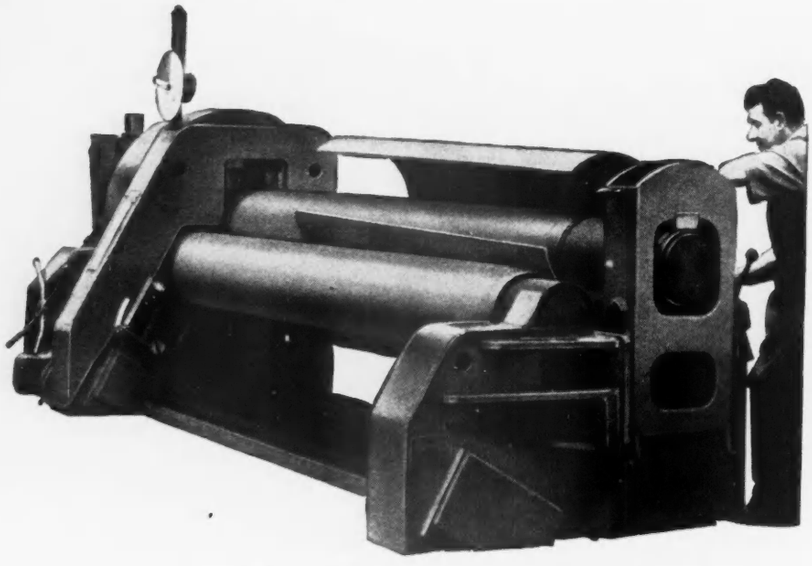
Bronx Plate Bending Rolls reduce Plate-Rolling costs on Batch and Mass-production work as well as on accurate cylinder jobs.

Great care and attention has been paid to provide the easiest system of control for the operation. In addition to circling these machines are suitable for all types of conical work.

There is a wide range of massively built Bronx Plate Bending Rolls to give consistent accuracy with thinnest to thickest steel plates up to 40 ft. wide.



Illustrated is a 3 roll initial-pinch Plate Bending Roll. Series 3 IP, 104. With capacity of 10" × ½", this machine is rolling cones tapering from 22" to 18" diameter, using 8" × ⅜" mild steel.

There are also Bronx Press Brakes, Guillotine Shears, Sheet and Plate Levelling Machines, etc. *Write for Catalogues.*

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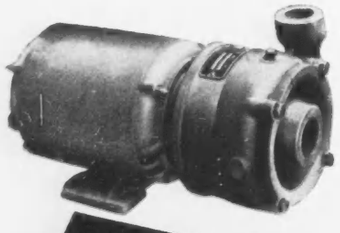
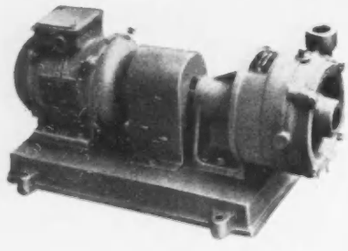


The unique design of the Girdlestone 'Seal' range of centrifugal pumps enables them to be mounted and driven in many different ways, and their exclusive mechanical shaft seal arrangement makes them suitable for all water duties and for handling a wide range of solvents and corrosive liquids.

'Seal' CENTRIFUGAL PUMPS



Available in five sizes from ¾" to 1½", with same shaft and flange dimensions for interchangeability of mounting. Constructed of cast iron, bronze or stainless steel. Illustrations show the pump fitted as a Motorpump Unit and as a Direct-coupled set.

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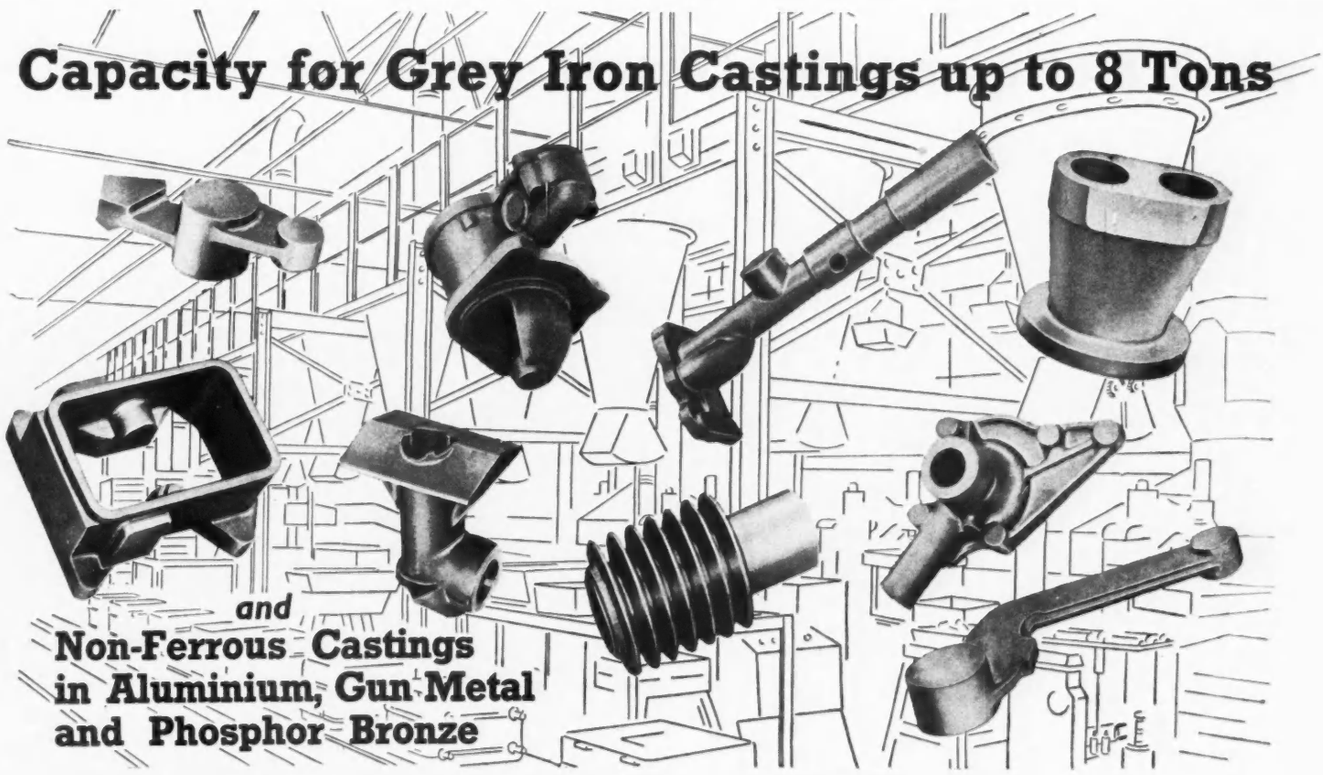

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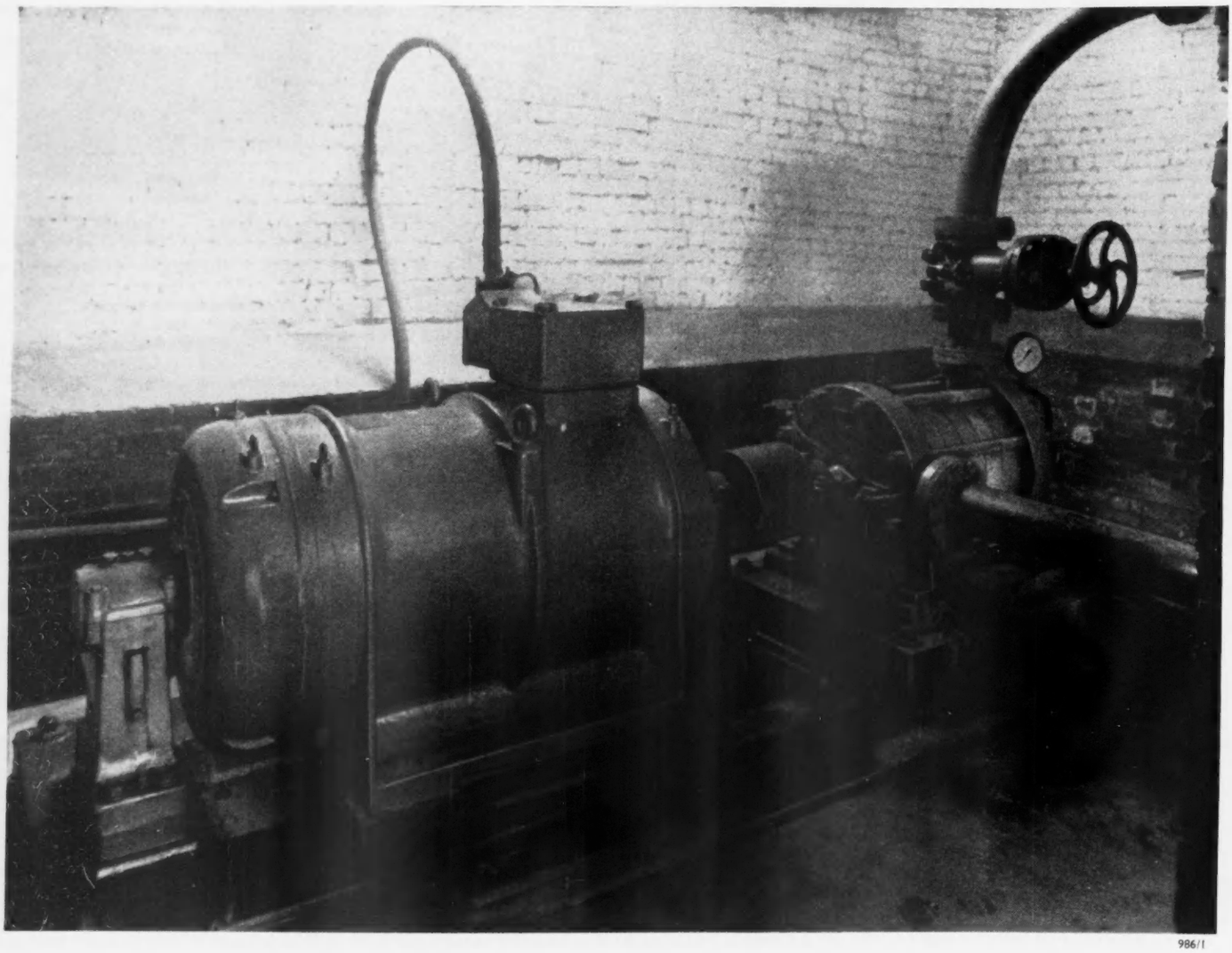

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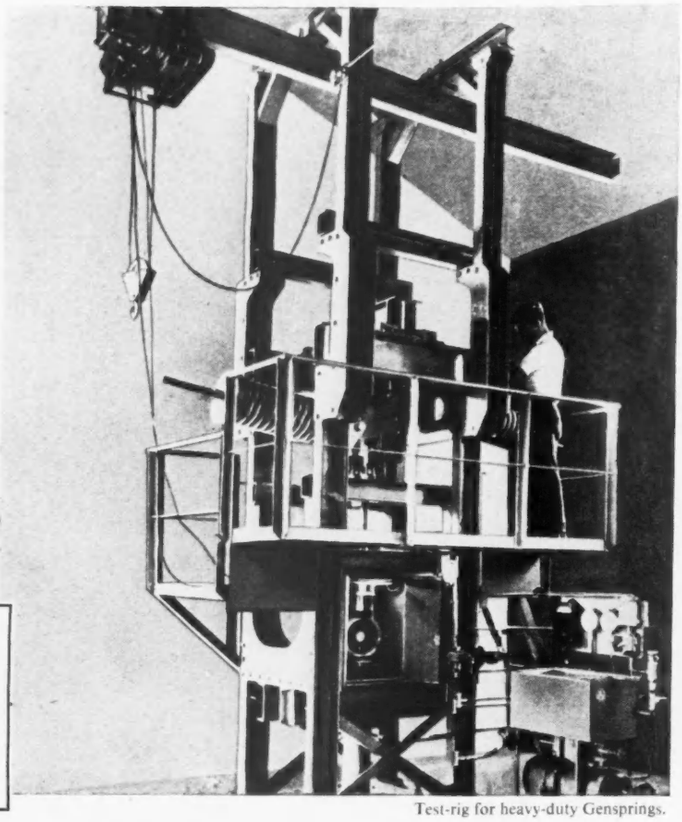
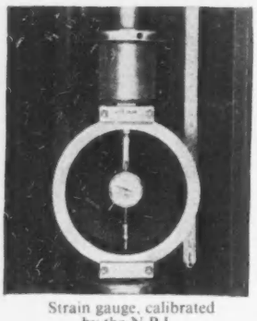
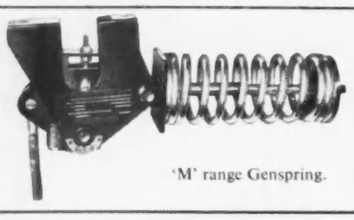


Test-rig for heavy-duty Gensprings.



Strain gauge, calibrated by the N.P.L.



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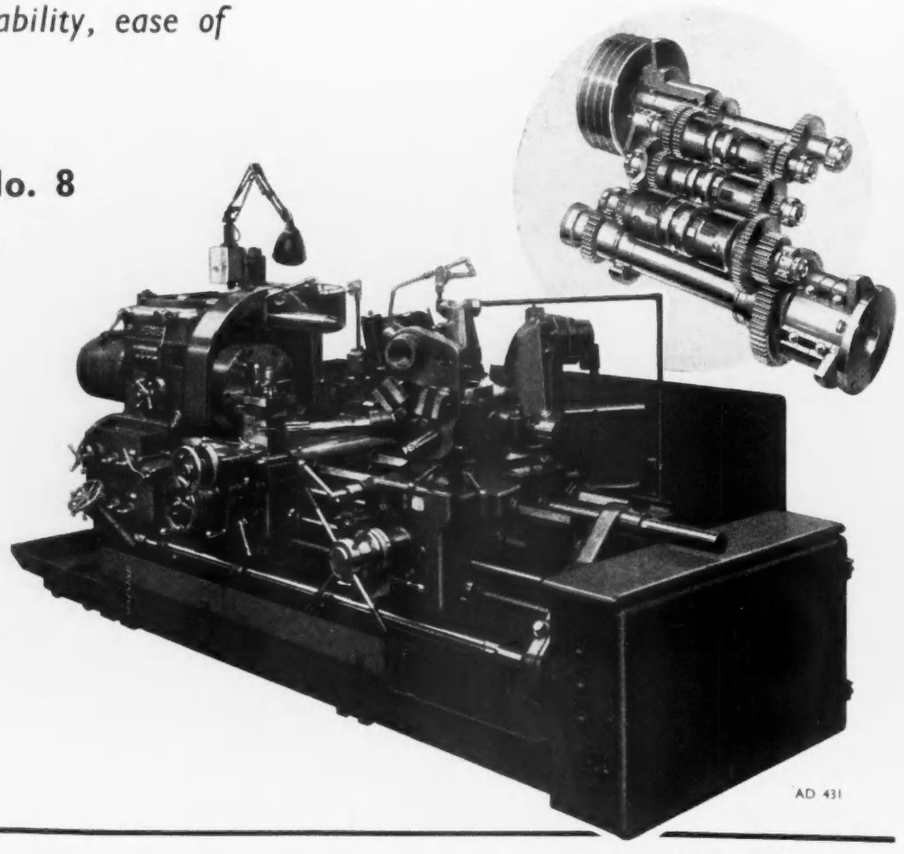

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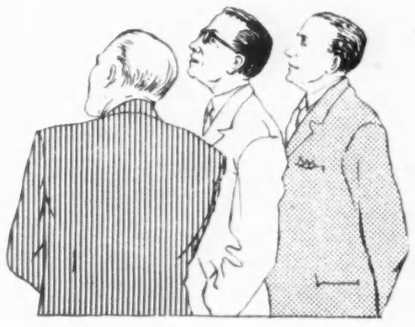

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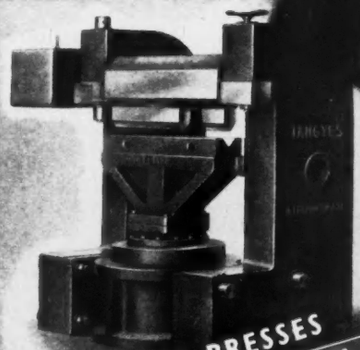

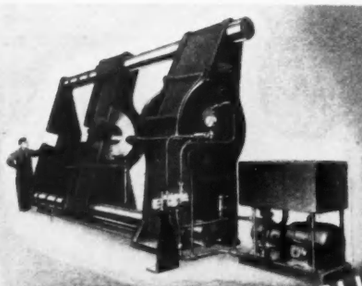

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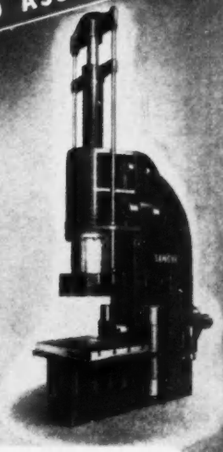
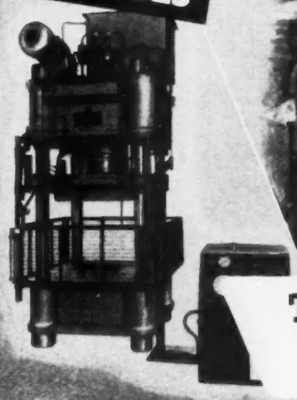


BENDING PRESSES FOUR COLUMN PRESSES



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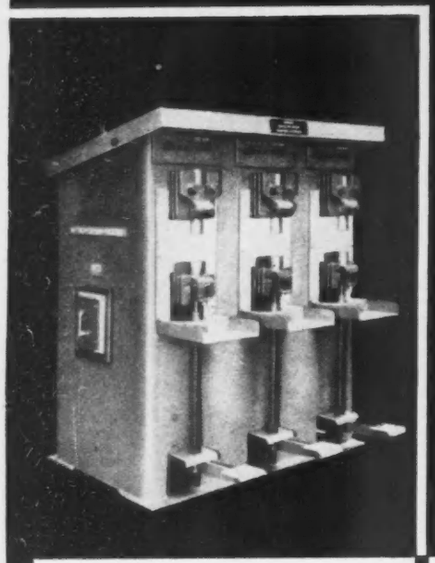
Hot rivets are always ready at a few seconds' notice with Metrovick resistance heating machines. The system is economical too, since the use of current is confined to periods of actual heating.

Both single and multi-head types are simple to operate and require little maintenance apart from electrode dressing. The electrodes are quickly adjustable and, in multi-head types, separate transformers are used so that rivets of different sizes can be heated simultaneously.

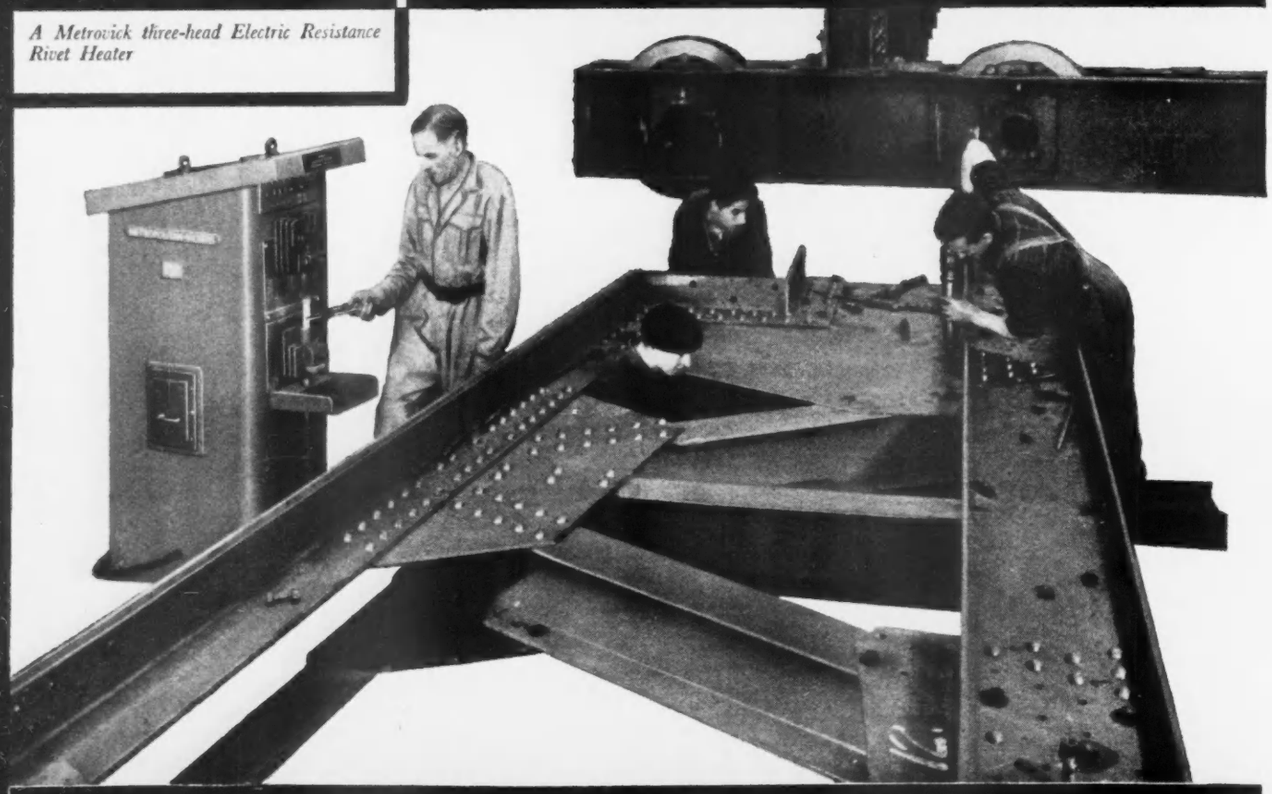
Heat is concentrated in the shanks whilst the heads of the rivets remain comparatively cool; full visibility during heating reduces the risk of burning. The machines are of strong, drip-proof construction enabling them to be used in semi-exposed positions.



A Metrovick three-head Electric Resistance Rivet Heater

CHARACTERISTIC DATA *(Applicable to each head)*

Equivalent continuous rating (kVA)	10	17	25
Maximum input in normal operation (kVA)	15	25	35
Normal heating range for M.S. rivets	$\frac{5}{16}$ in. x 1 in. to $\frac{7}{8}$ in. x 4 in.	$\frac{3}{8}$ in. x $1\frac{1}{4}$ in. to $1\frac{1}{8}$ in. x 4 in.	$\frac{3}{8}$ in. x $1\frac{1}{2}$ in. to $1\frac{1}{4}$ in. x 6 in.
Average output in lb. per hour	40	65	90



A Metrovick single-head electric rivet heater in use for heating rivets for a 160-ton crane at the Winsford, Cheshire, factory of Messrs. Henry Smith (Constructional Engineers) Ltd.

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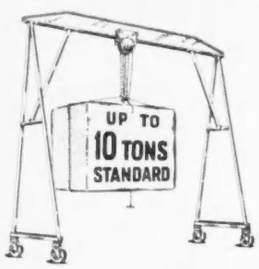

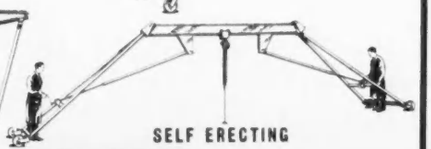

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MORE Schieldrop Industrial Oil Burners are used by

MORE and more leading engineers and

MORE Schieldrop S.P.O. Burners have been sold

IN GREAT BRITAIN **MORE** than any other make

Schieldrop Industrial Burners

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SCHIELDROP & CO. LTD., STOTFOLD, BEDS · Tel 414 (4 lines) BMJ

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STEAM · OIL · AIR · GAS · HIGH PRESSURE HOT WATER

For PRESSURES UP TO 900 P.S.I. TEMPERATURES UP TO 900° F.

VEE-REG

Manufactured by NEWMAN HENDER & CO. LTD.

GLOBE VALVES *are the answer*

A REGULATING STOP VALVE

THE STAINLESS STEEL CLACK AND SEAT GIVE MAXIMUM PROTECTION TO THE VALVE FACES WITH NEGLIGIBLE PRESSURE DROP.

SUITABLE FOR STEAM, GAS, OIL, AIR AND HIGH PRESSURE HOT WATER.

THE PORTED CYLINDER OF THE VALVE CLACK ENSURES AN EXCEPTIONALLY FINE DEGREE OF REGULATION

IMMEDIATE DELIVERIES ARE AVAILABLE FROM ANY OF OUR 9 BRANCHES

THE BRITISH STEAM SPECIALTIES LIMITED

Head Office FLEET STREET, LEICESTER

Also at London, Liverpool, Glasgow, Bristol, Manchester, Newcastle-on-Tyne, Birmingham, Belfast, Dublin

Telephone: Leicester 20885 (6 lines) Telegrams: Bust, Leicester

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Wire (Stainless) . . .

KNITTERS for the use of

As Manufacturers of Austenitic Stainless Steel Wire, we can cover all your requirements to D T D, BS, AISI, etc., specifications.

These specifications include DTD 189, DTD 489, DTD 549, DTD 571, DTD 734, DTD 2002, etc.

•

BS 2056, BS 1554, BS 1453, W10, W11, E20, etc.

•

AISI 302, AISI 304, AISI 316, AISI 321, AISI 347, etc. or to your own specifications. AID and ARB approved.

We have watched with wonder at Granny's knee, the speed and deftness with which our school stockings materialised from her clicking needles before our very eyes. Commercially minded customers of ours carry out similar operations with our famous AUSTENITIC STAINLESS STEEL WIRE at fantastically greater speeds. This is partly achieved, in no small measure we are told, by the assistance lent to their operations by our excellent product. In depicting the Wire Knitters Training School above (class of 1959), our fancy has run as freely as the wire we make. Though the method may be archaic, the principle remains that, whatever shape, size, knit or purl you require, the very best is available from us, and at prices which deserve to be increased beyond those prevalent, but for you, we will charge no more. Such generosity deserves, at least, your kind enquiry

STAINLESS STEEL WIRE CO. LIMITED

THE BARRACKS · LANGSETT ROAD · SHEFFIELD, 6

Telephone: SHEFFIELD 344241 *Telegrams:* FINEWYRE SHEFFIELD

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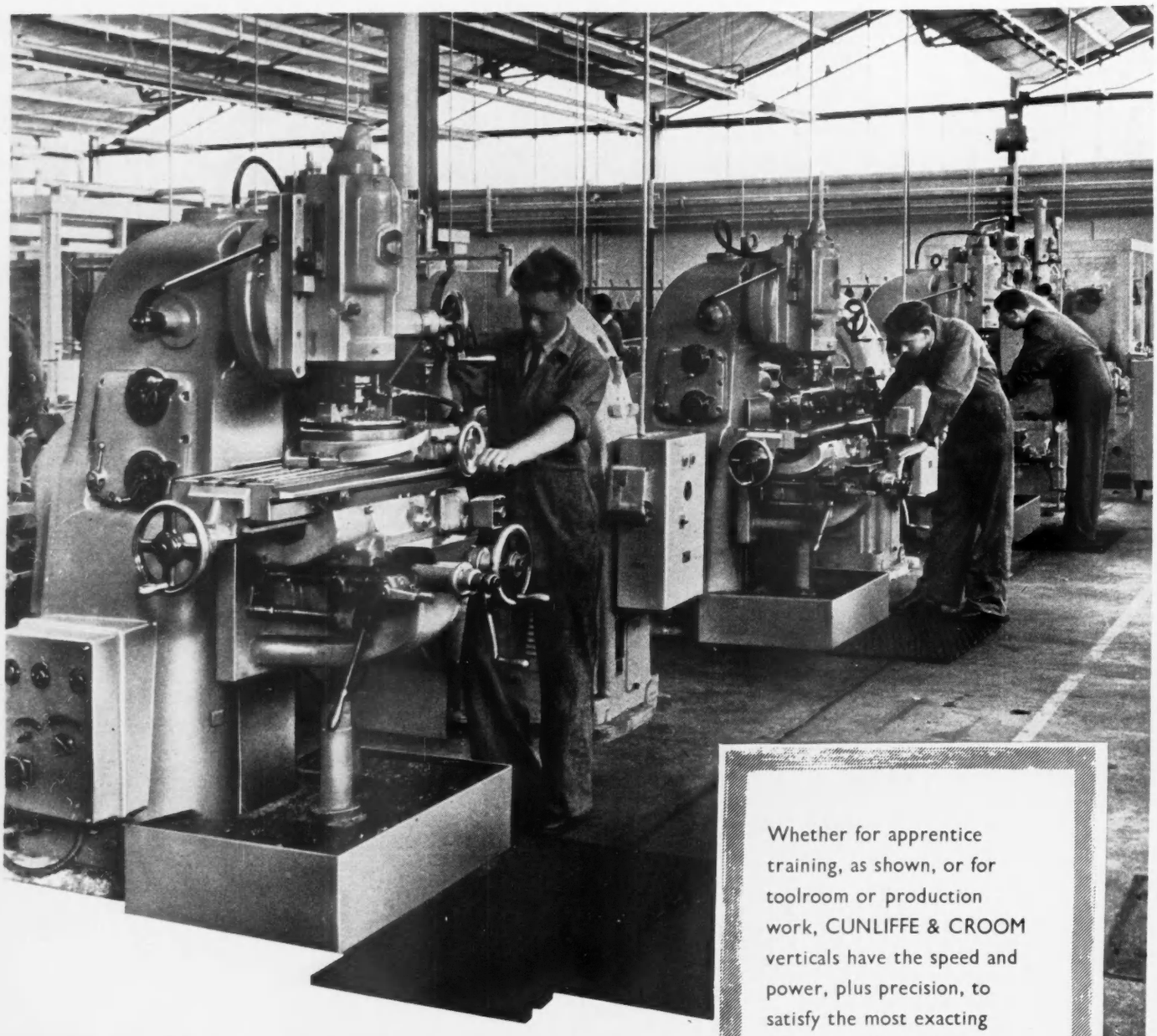
R



CUNLIFFE & CROOM VERTICALS

In the apprentice training school at Bristol Aero Engines Ltd

★ **SLIDING & SWIVELLING HEAD**

★ **POWER FEEDS IN ALL DIRECTIONS**

★ **SPEED AND FEED RANGE COVERING ALL MATERIALS**

Whether for apprentice training, as shown, or for toolroom or production work, CUNLIFFE & CROOM verticals have the speed and power, plus precision, to satisfy the most exacting demands. Note the massive design, the well-supported table and powerful knee . . . the sliding and swivelling head . . . features that make the CUNLIFFE & CROOM a really versatile machine, capable of tackling the most difficult jobs with ease, no matter what the material.

Get the details today. . . and ask, too, for information on our horizontal machine.

JAMES ARCHDALE & CO. LTD.

Registered Office : LEDSAM STREET, BIRMINGHAM 16 *Telephone : Edgbaston 2276*
Works : BLACKPOLE WORKS, WORCESTER *Telephone: Worcester 27081 (6 lines)*
A member of the Staveley Coal & Iron Co. Ltd. Group
Sole Selling Agents: ALFRED HERBERT LTD., COVENTRY *Telephone: Coventry 89221*

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THE ANSWER TO CONTROL PROBLEMS

THE HEART OF A GOOD DESIGN IS SIMPLICITY

- No bellows, bearing or ratio arms.
- The Positioner is an integral part of the Domotor, not an afterthought.
- The Domotor and Positioner reduce hysterisis to a fraction of that experienced with conventional designs.
- Available to 'open' or 'close' valve with increase of 3-15 psi signal.
- The action can be changed in a matter of minutes on site.

- DOMOTOR CONTROL
- CYLINDER AND HANDWHEEL OPERATED

AUDCO ANNIN Valves

Audco Annin Valves are recognised by Control Engineers and Valve Designers as the outstanding valve development of the past 25 years for the control of hot, cold, erosive, corrosive or viscous liquids.

AUDLEY ENGINEERING CO. LTD. NEWPORT, SHROPSHIRE
Telephone: Newport, Shropshire 3245 · Grams: Audley, Wellington, Shropshire

LONDON OFFICE 60-61 TRAFALGAR SQUARE, W.C.2. TELEPHONE TRAFALGAR 4401. TELEGRAMS: AUDCOLON, LESQUARE.

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NINE ELMS INDUSTRIAL PAINTS

ONE FOR EVERY PURPOSE

INCLUDING

HEAT RESISTANCE

CHEMICAL RESISTANCE

OIL RESISTANCE

Send your enquiries to:

T. & W. FARMILOE LTD.
INDUSTRIAL PAINTS DIVISION
17 ROCHESTER ROW
WESTMINSTER, S.W.1
VICTORIA 4480

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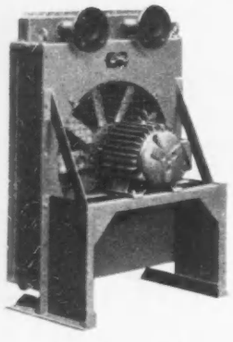
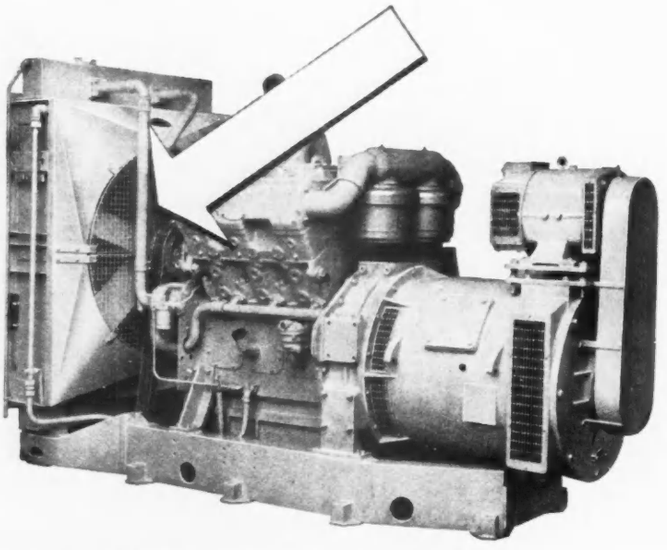
ENGINE COOLING IS OUR BUSINESS

Backed by fifty years of technical experience and "know-how," Spiral Tube Engine Coolers are soundly engineered and robustly constructed for long, trouble-free service, and are renowned for their high efficiency and great resistance to vibration. They have a wide range of applications and are in world-wide service on all the principal railways throughout the world. Coolers are also manufactured for use in connection with generators, alternators, etc.



COOLED BY SPIRAL TUBE
Air Blast Compressed Air Cooler.



COOLED BY SPIRAL TUBE. Paxman 6: R.P.H. Standard Alternator Set with G.E.C. electrical equipment 125 K.W. at 1,000 R.P.M.

★ *Consult our Technical Advisory Service*

SPIRAL TUBE
Engine Coolers

THE SPIRAL TUBE & COMPONENTS COMPANY LIMITED, OSMASTON PARK ROAD, DERBY. TELEPHONE: DERBY 48761 (3 lines)
LONDON OFFICE: ABBEY HOUSE, 16 HIGH STREET, WATFORD. TELEPHONE: 26781-2. GRAMS: SPIRATUCOM WATFORD
SCOTTISH OFFICE: MESSRS. McCULLOCH & MILLER, 180 WEST REGENT STREET, GLASGOW, C.2. TELEPHONE: CITY 4704/5.

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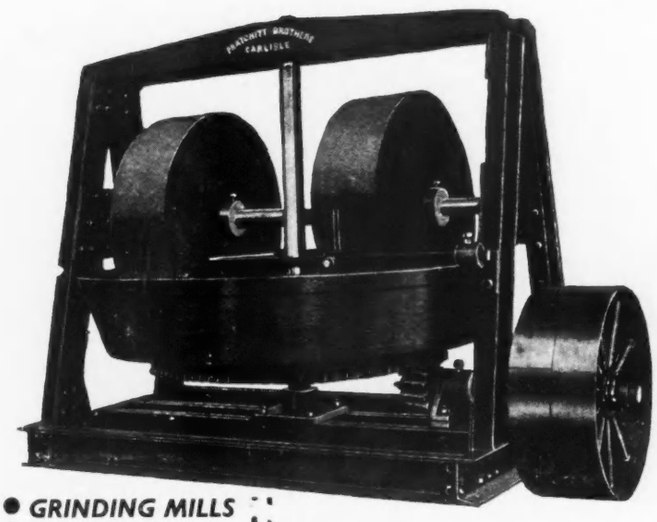
PRATCHITT MODERN MILLS



- *GRINDING MILLS*
- *PAN MILLS*
- *EDGE RUNNER MILLS*

for grinding and mixing Mortar Sand, Ores, Minerals, etc.

Enquiries also invited for:

Elevators and Storage Hoppers, Impregnating Plants, Calciners, Rotary Dryers, Mixers and Blenders, Gypsum Plant, Castings up to 5 tons in weight, General Engineering Plant. Equipment manufactured to customers' drawings and specification.

PRATCHITT BROTHERS LTD · CARLISLE

ENGINEERS AND IRONFOUNDERS

PB. 13

Enter No. 1471 on reply card

Sifbronze Welds are Good Welds. Whether for low temperature welding or for full fusion welding, there is a 33-rod range covering every class of gas-welding operation. Quality counts, and Sifbronze rods are first-quality rods and are made to BSS 1453 and BSS 2901.

If you are not using Sifbronze, write now for full details.

"SIFBRONZE WELDS STAY WELDED!"

says Will the Welder

SUFFOLK IRON FOUNDRY (1920) LTD., STOWMARKET SUFFOLK

E.B.1

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SKILLED MEN!

USE YOUR KNOWLEDGE IN A WORTHWHILE JOB

VACANCIES FOR ARTIFICERS

Vehicle Gun
Radio Radar
Instrument
Electrical Control

CARPENTERS
ELECTRICIANS
SHEET METAL WORKERS
TURNERS
WELDERS

in

THE ROYAL ELECTRICAL & MECHANICAL ENGINEERS

Up to £25 tax-free Bonus plus first-rate wages for two weeks of your time

ARE you in a skilled trade? Then you can probably add a tidy sum to your income by joining the Army Emergency Reserve. For one thing, you get pay and allowances at full Regular Army rates whilst in camp. And the more your skill is worth in civilian life, the higher your Army trade pay will be. Better still, you also get £9-£25 bonus tax-free.

For this you just spend 14 days a year at a camp, working on your own speciality. And money's not the only profit you get from that. You get a grand refresher course, giving you a lot of new ideas, and putting you right in touch with the latest Army developments. And you get a welcome break from the usual routine, with sports, games and a great social life. For the place is full of people with the same interests as yourself. Don't miss this chance! Send off the coupon now to: H.Q., A.E.R., R.E. (Field & Works), Harper Barracks, Ripon, Yorks.

POST THIS OFF RIGHT AWAY!

Please send me—without obligation—the illustrated booklet telling all about the Army Emergency Reserve.

NAME _____

ADDRESS _____

_____

TRADE _____ (JU/AER)

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CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

AUSTRALIA

UNIVERSITY OF NEW SOUTH WALES

VACANCY FOR PROFESSOR OF ELECTRICAL ENGINEERING

The University invites applications for appointment to a newly created PROFESSORSHIP OF ELECTRICAL ENGINEERING in the School of Electrical Engineering at Sydney.

Salary will be £A3768 per annum.

The present professorial staff comprises the Head of the School, Professor R. E. Vowels and one Associate Professor.

While the area of specialisation is open, preference will be given to applicants in the field of electrical communications.

The successful applicant will be expected to take part in the administration and development of the School and to promote research and post-graduate study in his chosen field.

Subject to satisfactory medical examination, the successful applicant will be eligible to contribute to the State Superannuation Fund which provides a pension of £A1638 per annum.

Professors are eligible for six months' study leave on full salary after three years of service, or twelve months after six years of service.

Subject to the consent of the Council of the University, they may engage in a limited amount of higher consultative work.

With the approval of the University and its bankers, married men may be assisted by loans to purchase a home.

The University reserves the right to fill the Chair by invitation.

First class ship fares to Sydney of appointee and family will be paid.

Four copies of applications together with the names of three referees and a recent photograph, should be lodged with the Agent General for New South Wales, 56–57, Strand, London, W.C.2, and a copy forwarded by airmail in an envelope marked "University Appointment" to the Bursar, The University of New South Wales, Post Office, Box 1, Kensington, New South Wales, Australia, before 21st December, 1959. E7799

LONDON COUNTY COUNCIL

HAMMERSMITH COLLEGE OF ART AND BUILDING

LECTURER AND/OR SENIOR LECTURER

Hammersmith College of Art and Building. Department of Building, Structural Engineering and Surveying.

LECTURER and/or SENIOR LECTURER in Structural Engineering required for A.M.I.Struct.E. and similar examination courses; should be competent in Design of Structures and allied subjects, with suitable professional qualifications and industrial experience. Teaching experience desirable.

Salary scales: Senior Lecturer: £1550 by £50 to £1750. Lecturer: £1370 by £35 (4) by £40 to £1550. Plus London Allowance £38 or £51. Entry to scale possibly above minimum for certain approved experience. Application forms from Secretary at College, Lime Grove, London, W.12, to be returned within 14 days of advert. date. (2303) E7785

UNIVERSITY OF MANCHESTER

SENIOR LECTURER AND LECTURER IN ENGINEERING (MECHANICAL)

Applications are invited for the posts of SENIOR LECTURER AND LECTURER IN ENGINEERING (MECHANICAL). Preference will be given to candidates with a major interest in Applied Thermodynamics or Applied Mechanics, especially Theory of Machines. Some experience of Mechanical Design would be an advantage. University regulations permit teaching staff to read for the degrees of M.Sc. and Ph.D. The salary scales per annum are as follows: Senior Lecturer, £1700 to £2050; Lecturer, £900 to £1650. Membership of F.S.S.U. and Children's Allowance Scheme. Initial salary according to qualifications and experience. Applications should be sent not later than November 28th, 1959, to the Registrar, The University, Manchester, 13, from whom further particulars and forms of application may be obtained. Applications by airmail (no forms) will be considered from overseas candidates. E7787

ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM, BERKSHIRE

SENIOR LECTURERS OR LECTURERS

Royal Military College of Science, Shrivenham, Berkshire, requires Two Male SENIOR LECTURERS or LECTURERS in MECHANICAL ENGINEERING, one to specialise in Heat Engines and one in Machines. Teaching at University level, to include lecturing to students taking all parts of London External B.Sc. (Eng.) Examinations, and organisation of related laboratory and course work; possibly some post-graduate lecturing and expected to carry out research individually or as part of team.

Qualifications: First or Second Class Honours Degree in Mechanical Engineering, together with background of workshop practice. These additional qualifications an advantage: (A) Heat Engines: Specialisation in steam power plants; experience with nuclear power station equipment, especially reactors. (B) Machines: Practical experience, including design, in mechanical engineering related to small mechanisms involving precision workmanship, in automobile engineering, or in engineering aspects of vibration.

Salary: Senior Lecturer, £1166–£1420; Lecturer, £615–£1120. Starting pay may be above minimum: credit for post-graduate experience and National Service. Superannuable with good prospects of permanency. Quarters in residential officers' mess for single men. Possibility of houses after waiting period for married men.

Particulars and forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C.724/9A. Closing date, 30th November, 1959. E7842

L.C.C. HAMMERSMITH COLLEGE OF ART AND BUILDING, LIME GROVE, SHEPHERDS BUSH, W.12

TEACHERS IN STRUCTURAL ENGINEERING

L.C.C. Hammersmith College of Art and Building, Lime Grove, Shepherd's Bush, W.12. Department of Building, Structural Engineering and Surveying.

Applications are invited for part-time day and evening TEACHERS IN STRUCTURAL ENGINEERING subjects:

R.c. design,
Prestressed Concrete Design,
Structural Steel Design,
Timber Design.

All at advanced level for students preparing for final examination of the Institution of Structural Engineers.

Generally appointments are intended for the session's work, but applications are particularly invited from competent specialists, who although unable to contribute a whole session would give a short course of lectures on a particular subject over a period of, say, 6 to 8 weeks.

Application forms and further particulars can be obtained from the Secretary at the College. (2416) E7823

CITY OF BIRMINGHAM EDUCATION COMMITTEE

MATTHEW BOULTON TECHNICAL COLLEGE, SUFFOLK STREET, BIRMINGHAM, 1

Principal: J. C. MARTIN, M.A., A.M.I.E.E., A.M.Brit.I.R.E.

ASSISTANT GRADE "B"

Applications are invited from suitably qualified persons for the following appointment in the Engineering Department.

ASSISTANT GRADE "B"

The person appointed will be required to teach Ordinary National Certificate (Mechanical Engineering) and City and Guilds Machine Shop Courses. Subjects chiefly Mathematics, Mechanics and Engineering Drawing.

(Salary in accordance with the Burnham Technical Scale: £700 by £27 10s. to £1150 plus additions and allowances as appropriate.)

Application forms and further particulars may be obtained from the Principal to whom the completed forms should be returned as soon as possible. E7791

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

TWICKENHAM TECHNICAL COLLEGE
EGERTON ROAD, TWICKENHAM, MIDDLESEX

SENIOR LECTURER

Required, as soon as possible, SENIOR LECTURER to teach Mechanical Engineering subjects for Higher National Diploma and Post-Higher National Certificate Courses in Mechanical Engineering.

Candidates should state the Higher National Certificate subjects which they can offer, but preference will be given to a candidate offering Structures and/or Hydraulics.

Candidates should have had good industrial and preferably some teaching experience. A degree or equivalent qualification is desirable.

Salary in accordance with the new Burnham Scales (1959) viz. £1550 by £50 to £1750, plus London Allowance (men).

Application form and further particulars (foolscap s.a.e.) from the Principal. Closing date 1st December 1959.

C. E. GURR, M.Sc., Ph.D.,
E7821 Secretary to the Education Committee.

UNIVERSITY OF ADELAIDE

LECTURER IN CIVIL ENGINEERING

Applications are invited for the above appointment. No preference is given for a particular field of interest on the part of a candidate.

Salary scale: £A1500 by £A80 to £A2060 with superannuation on the F.S.S.U. basis.

Copies of the general conditions of appointment of Lecturers in the University may be had on application to the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1, or to the Registrar; the Calendar of the University may be seen in the Library of any University which is a member of the A.U.B.C.; housing help is available; any further information desired will be supplied on request.

Applications in duplicate and giving the information listed in the general conditions of appointment, should reach the Registrar, The University of Adelaide, Adelaide, South Australia, not later than December 7, 1959. E7772

WARRINGTON EDUCATION COMMITTEE

WARRINGTON TECHNICAL COLLEGE

LECTURER IN MECHANICAL ENGINEERING

LECTURER IN MECHANICAL ENGINEERING required to take the responsibility for teaching one or more of the subjects, Hydraulics, Structures, Machines, Strength of Materials, in the Higher National Certificate courses. Salary in accordance with the Burnham Technical Scale for Lecturers, i.e. £1370 by £35 to £1550.

Application forms and further particulars may be obtained from The Chief Education Officer, Education Offices, Sankey Street, Warrington. E7818

MINISTRY OF AVIATION

ELECTRONIC ENGINEERS

ELECTRONIC ENGINEERS required for development, planning, manufacture or inspection of Guided Missile and Other Electronic Equipment by Ministry of Aviation at Blackburn, Lancs., London, and other locations.

Excellent Career Prospects. Posts in Professional Engineer (Basic Grade). Starting salary £780–£1300 p.a. according to age and location. Opportunities for established appointments arise. Engineering apprenticeship or equivalent and corporate membership of Institution of Electrical Engineers, or exempting qualification required. Experience of modern electronic practice in communication or radar fields desirable. Knowledge of guided weapons practice and servo-mechanisms an advantage. Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.478/9A/BF. E7804

BUCKINGHAMSHIRE EDUCATION COMMITTEE

SLOUGH COLLEGE OF FURTHER EDUCATION

Principal: R. EDGAR, M.Sc., M.A.

MAINTENANCE ENGINEER

Applications are invited from suitably qualified men for the post of MAINTENANCE ENGINEER, to be responsible for:

(i) General maintenance of premises and equipment.

(ii) Maintenance of central heating and domestic hot water systems, gas systems, extractor ventilation, electric power installations, water pressure pumps, compressed air machines, &c.

The person appointed will be responsible to the Principal subject to the maintenance of the fabric of the building and of its services being carried out under the general direction of the County Architect.

Salary will be paid on the scale £765 to £880 per annum, and the post will be superannuable.

For further details and forms of application prospective candidates should forward a stamped, addressed envelope to the Principal at William Street, Slough. E7833

ROAD RESEARCH LABORATORY (D.S.I.R.), HARMONDSWORTH, MIDDLESEX

APPOINTMENTS

Road Research Laboratory (D.S.I.R.), Harmondsworth, Middlesex, requires CIVIL ENGINEERS, PHYSICISTS, MATHEMATICIANS, STATISTICIANS, in Senior Scientific/Scientific Officer grades, for work in Tropical Section of R.R.L., as follows:

(a) CIVIL ENGINEERS AND PHYSICISTS for work on problems of soil mechanics, road construction and maintenance in overseas territories.

(b) CIVIL ENGINEERS, MATHEMATICIANS AND STATISTICIANS for work on road traffic and transport, and on road safety problems of overseas territories. Work based at Road Research Laboratory at Harmondsworth, and involves regular visits to overseas territories, with, in some cases, postings to overseas territories for periods of 1–2 years on specific projects.

Qualifications: 1st or 2nd Class Hons. Degree. At least 3 years' post-graduate experience required for S.S.O. Starting salaries within range: S.S.O., £1233–£1460; S.O., £655–£1150. Normal prospects of promotion to Principal Scientific Officer in mid-thirties (range up to £2120) with possibilities of higher posts. Five-day week. Closing date, 14th December, 1959, for applications in United Kingdom. Late applications from overseas candidates considered.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting E.450/9A. E7843

NEW SOUTH WALES, AUSTRALIA

DEPARTMENT OF MAIN ROADS

CIVIL ENGINEERS

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination, and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56, Strand, London, W.C.2. E7800

PUBLIC APPOINTMENTS

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS required in following localities :

LONDON AREA : MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics, to carry out research programme in particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for research on precision gear design. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles ; knowledge of theoretical hydrodynamics and theory of control mechanisms an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICIST for acoustic analysis. APPLIED MATHEMATICIAN for work with electronic computers, with special reference to research into general underwater physical problems. ELECTRONIC PHYSICISTS for data handling and analysis problems. EXPERIMENTAL PHYSICIST for research in underwater acoustics. PHYSICIST interested in operation performance. CLASSICAL PHYSICISTS.

BALDOCK : PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH : PHYSICISTS with experience in field of microwave techniques. ELECTRONIC/ELECTRO-MECHANICAL ENGINEERS (experience in servo-mechanisms an advantage).

HASLEMERE : ELECTRONIC ENGINEER.

PORTLAND : PHYSICISTS or APPLIED MATHEMATICIANS for research in underwater acoustics. PHYSICISTS (general). ELECTRICAL ENGINEERS with advanced electronic design experience. MECHANICAL ENGINEERS. PHYSICAL CHEMISTS.

POOLE : CHEMICAL ENGINEERS. CHEMISTS with experience in rubber technology.

ROSYTH : MECHANICAL ENGINEER with experience in welding development. ELECTRONIC PHYSICISTS.

Candidates must normally be natural born British subjects of natural born British parents, with First or Second-Class Hons. Degrees or equivalent qualifications. S.S.O.s must have had three years' post-graduate experience and be not less than 26 years of age. Salaries (men) : S.S.O., £1233–£1460 ; S.O., £655–£1150 (London), somewhat lower in provinces.

Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those under 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.483/9A). E7844

WEY VALLEY WATER COMPANY

CIVIL ENGINEERING ASSISTANT

CIVIL ENGINEERING ASSISTANT, commencing salary £750–£850 per annum, with annual increments, plus car allowance.

Applications are invited for the above appointment on the permanent staff of the Wey Valley Water Company.

Qualifications : Applicants must have been trained as Civil Engineers and have either passed Parts I and II of the Institution of Civil Engineers' examination or hold a University Degree. Preference will be given to those who have had experience in the office of a Water Engineer.

The applicant should hold a licence to drive a car.

The appointment is permanent and pensionable.

Applications, stating age, qualifications, present position and salary, education, training and experience, should be sent to the Engineer and Works' Manager, Wey Valley Water Company, 3, Downing Street, Farnham, Surrey, not later than 25th November, 1959. E7738

EAST AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION

ASSISTANT MECHANICAL ENGINEER

Pensionable appointment. Salary £1170–£1755. Free passages. Free furnished quarters.

Candidates 25–35 years must have passed or be exempt from Parts I and II of the examination of the Institution of Mechanical Engineers and have served an apprenticeship with a British railway or a firm of locomotive or diesel engine builders, followed by at least 4 years' practical experience in the Mechanical Department of such an undertaking.

Write Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 173/06/D4. E7783

NATIONAL PHYSICAL LABORATORY, TEDDINGTON, MIDDLESEX

EXPERIMENTAL OFFICER/ ASSISTANT EXPERIMENTAL OFFICER

National Physical Laboratory, Teddington, Middlesex, requires EXPERIMENTAL OFFICER/ASSISTANT EXPERIMENTAL OFFICER preferably with engineering training or some experience in testing materials, to work in Metallurgy Division on fatigue of metals. Work involves design, development and operation of fatigue testing equipment for carrying out basic research investigations. Qualifications : H.N.C. Mechanical Engineering or equivalent. Salary ranges : (Men) E.O. (minimum age 26) £1005–£1233. A.E.O. £397 10s. (age 18)–£880. Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C 60/9A. Closing date, 20th November, 1959. E7805

GOVERNMENT OF EASTERN NIGERIA

MINISTRY OF AGRICULTURE

AGRICULTURAL ENGINEER

To supervise the mechanised agricultural activities of the Ministry including the development of existing mechanisation schemes, and to advise on mechanisation problems and carry out research in crop processing machinery, &c.

The post offers scope for the man with ability, initiative and ideas to build up an Agricultural Engineering Section worthy of the future agricultural development of the Region.

Contract appointment for two tours. Salary range £1728–£1956 with gratuity. Free passages. Quarters at low rent. Generous home leave.

Candidates must be A.M.I.Mech.E. or B.Sc. (Mechanical or Agricultural Engineering) with at least five years post-graduate relevant experience and be not more than 55 years.

Write Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 63/411/09/D4. E7792

MINISTRY OF LABOUR AND NATIONAL SERVICE

TORRY RESEARCH STATION, ABERDEEN

RESEARCH ENGINEERS

RESEARCH ENGINEERS (2) required at Torry Research Station, Aberdeen, in team whose work ranges from fundamental research on heat transfer to development of new processes and equipment for fishing industry. Post A, graded Senior Scientific Officer ; Post B, Scientific Officer.

Qualifications : 1st or 2nd Class Hons. Degree in Engineering (or equivalent), plus (for S.S.O.) at least 3 years' post-graduate experience in refrigeration or allied heat transfer field. For both posts ability to translate research results into sound engineering design is essential. Practical knowledge of refrigeration applications or food processing an advantage.

Salary range : S.S.O. (Men), £1200–£1420 ; S.O., £635–£1120.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C.584/9A. E7845

MID-WORCESTERSHIRE HOSPITAL MANAGEMENT COMMITTEE

HILL TOP HOSPITAL, BROMSGROVE, WORCS.

ASSISTANT ENGINEER

ASSISTANT ENGINEER required for duty at the above Hospital. House available for rental. Post vacant 1st January, 1960.

Applicants should have served an engineering apprenticeship and preferably be in possession of either the Ordinary National Certificate or Certificate of Competency in Marine Engineering. Experience of building maintenance work and electrical installations is desirable.

Salary scale : £575 by £25 to £700 per annum.

Applications, with full details, and the names of two referees, to be sent to the Group Secretary, Mid-Worcestershire Hospital Management Committee, Birmingham Road, Bromsgrove, by 18th November, 1959. E7834

NORTH THAMES GAS BOARD, MONCK STREET, WESTMINSTER, S.W.1

SENIOR DRAUGHTSMAN

SENIOR DRAUGHTSMAN required by North Thames Gas Board at Monck Street, Westminster, S.W.1, for the design and detailing of reinforced concrete structures and foundations associated with gas works.

Candidates should possess the Higher National Certificate as a minimum qualification. Commencing salary will be within the range £763 to £962 per annum according to qualifications and experience.

The appointment will be of a permanent nature and the successful candidate will be required to join the Board's staff contributory pension scheme.

Applications, stating age, qualifications and experience, should be sent within ten days of the appearance of this advertisement, to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference TE/767. E7824

BRITISH TRANSPORT COMMISSION

CHIEF SIGNAL ENGINEER'S DEPARTMENT

ASSISTANT (DESIGN)

British Transport Commission require ASSISTANT (DESIGN) in the Chief Signal Engineer's Department, with wide experience in design, manufacture and application of electric and electro-mechanical apparatus suitable for use in the field of railway signalling. Applicants must be conversant with modern techniques and materials for this purpose, including application of electronics. Professional qualification essential.

Salary range : £1420–£1695.

Superannuation scheme. Certain travel facilities. Medical examination. Write, stating age, qualifications and experience to Director of Establishment, British Transport Commission, 222, Marylebone Road, London, N.W.1, within 14 days. Addressed envelope for acknowledgment. E7779

REPUBLIC OF THE SUDAN

SUDAN RAILWAYS

SENIOR MECHANICAL ENGINEER

Applications are invited from those suitably qualified to fill a vacancy of SENIOR MECHANICAL ENGINEER in the Sudan Railways. Applicants must have the following qualifications :

Hold a degree in engineering or be Corporate Members of the Institution of Mechanical Engineers. Have served a full apprenticeship on railways or for a firm of locomotive manufacturers of repute and must have filled a position of responsibility in locomotive engineering of not less than 15 years. Should be familiar with the running and maintenance of both steam and diesel electric locomotives, have had experience on progress work and piece work and have exercised full control.

Appointments will be made on contract (with bonus) for a period of three years in the salary range from £S.1750–£S.2170 (annual increments)—the Sudanese pound equals £1 0s. 6d. sterling. Starting rate will be fixed according to age, qualifications and experience. A cost of living allowance is payable and an initial outfit grant of £S.50 is on appointment. Annual home leave accrues at the rate of seven days per month.

Applications in writing quoting age, qualifications and experience with copies of two recent testimonials to The Sudan Embassy, Personnel Section, Cleveland Row, St. James's, London, S.W.1. Closing date 30th November, 1959. E7827

CENTRAL ELECTRICITY GENERATING BOARD

PURCHASING AND CONTRACTS DEPARTMENT

Applications are invited for the post of **PRINCIPAL ASSISTANT** at Headquarters, London, S.E.1. Candidates should be experienced in procedures, terms, and conditions, covering contracts for Civil Works and plant for generation and transmission.

Applicants should have commercial experience, preferably in connection with the type of contracts placed by the Board and be capable of controlling a section responsible for receipt, recording and examination of contract documents, together with the preparation of returns, schedules, and records.

Commencing salary within the scale £1515–£1635 p.a.

Applications stating age, qualifications, experience, present position, and salary to the Personnel Officer, 24–30, Holborn, London, E.C.1, by 18th November. Envelopes should be marked "Confidential Ref. ENR/437." E7797

SHEFFIELD CORPORATION WATERWORKS

YORKSHIRE DERWENT SCHEME

Applications are invited for the following appointments on the staff of the Waterworks General Manager and Engineer (J. Noel Wood, M.I.C.E.) :

(a) CHIEF ASSISTANT ENGINEERS i/c Subsections. Salary : N.J.C. Scale "A" (£1215–£1445)—2 vacancies.

(b) SENIOR ENGINEERING ASSISTANTS. Salary A.P.T.V. (£122½–£1375)—3 vacancies.

Successful applicants will be engaged upon the design and construction of the works of the Yorkshire Derwent Scheme, comprising a River Intake and Treatment Plant, a 40-mile Aqueduct, Service Reservoirs, Pumping Stations and Plant.

Applicants must be Chartered Engineers experienced in design and construction of major works. Previous employment on similar water supply schemes would be an advantage.

Appointments are superannuable and subject to medical examination and to the national conditions of service as applied by the City Council.

Applications endorsed with the title of the post applied for are to be forwarded to the undersigned by 1st December, 1959, stating age, qualifications, past and present appointments (with dates and salaries), details of relevant experience and schemes engaged upon, together with the names of two referees.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield, 1. E7798

TENDERS

INDIA STORE DEPARTMENT

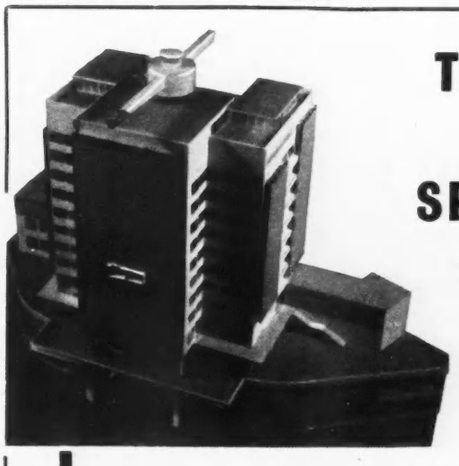
MECHANICAL FORGING PRESS

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

TENDER REF. No. 20055/59/ACR/HAL. MECHANICAL FORGING PRESS, 1000 tons capacity.

The Tender forms with Schedules and Specifications which are returnable on the 7th December, 1959, may be obtained from the above office (C.D.N. Branch) on payment of a fee of ten shillings (not refundable) for each tender.

The applications for Tenders should clearly state the above reference number. E7793



TENDER FOR SPECIAL CRANE

Firms of repute who wish to be considered for tendering for the design, fabrication and erection of a crane which will be a permanent feature at the top of the Monico building to be erected in Piccadilly, London, are invited to lodge their application by 10.00 hours on 18th November, 1959, with **Scott and Wilson, Kirkpatrick and Partners, Consulting Civil and Structural Engineers, of 47, Victoria Street, Westminster, S.W.1.**

Application to tender must be accompanied by brief particulars of previous work of the applicants, which they consider qualifies them to tender.

The above photograph indicates the architectural treatment of the crane envisaged. The crane will have a retractable horizontal boom which will extend to a maximum radius of 94 feet. The crane will be required to hoist plant weighing 5 tons at a radius of 30 feet to a plant room on the 13th floor and to hoist cradles weighing 1½ tons at a radius of 74 feet up and down the face of the building. It will also be required to support similar cradles for window cleaning and painting and for stone cleaning.

E7831

Classified Advts. continued on page 150

TENDERS

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the supply of :

TENDER REF. No. 20057/59/ACR/HAL

JIG BORER.—Single column with Optical Metric Measuring, infinitely variable range, longitudinal and transverse movement of 1000mm. and 600mm respectively.

The tender forms with Schedules and Specifications which are returnable on the 7th December, 1959, may be obtained from the above office (C.D.N. Branch) on payment of a fee of 10s. (not refundable) for each tender.

The applications for Tenders should clearly state the above reference number. E7778

MINISTRY OF TRANSPORT

LONDON-FISHGUARD ROAD A.40

WESTERN AVENUE A.40—JUNCTION WITH HANGER LANE WESTERN AVENUE UNDERPASS

SUPPLY OF LIGHTING FITTINGS

TENDERS are invited from established Electric Lighting Fitting Manufacturers, who can provide evidence to show that they have successfully carried out previous similar contracts, for the DESIGN, MANUFACTURE and SUPPLY of purpose-made LIGHTING FITTINGS required for the illumination of tunnels, approach ramps and pedestrian subways being constructed in connection with the above project.

Copies of the Contract Documents and Drawings may be obtained from the Engineer for the Works, Messrs. Rendel, Palmer and Tritton, Chartered Civil Engineers, 125, Victoria Street, London, S.W.1, on receipt of a deposit of £5 which will be refunded on submission of a bona fide tender that is not subsequently withdrawn.

Completed Tenders, in duplicate, must be delivered to the Engineer in a plain sealed envelope endorsed "Western Avenue Underpass—Tender for Lighting Fittings" not later than 10 a.m. on December 7th, 1959.

The Minister is not bound to accept the lowest or any tender. E7758

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the supply of :

REF. No. 20056/59/ACR/HAL

DROP STAMPS.—Capacity 1 and 3 tons with hydraulic working tup holding up device.

The tender forms with Schedules and Specifications which are returnable on 7th December, 1959, may be obtained from the above office (C.D.N. Branch) on payment of a fee of 10s. (not refundable) for each Tender.

The applications for tenders should clearly state the above reference number. E7782

EDUCATIONAL

UNIVERSITY OF LONDON KING'S COLLEGE

STUDENTSHIP

UNIVERSITY OF LONDON KING'S COLLEGE offers a STUDENTSHIP of £800 a year, made available by Joseph Lucas, Ltd., for research into the initiation of explosions in gases, vapours and powder clouds, or into the mixing of powdered materials. Applicants should have a good Honours Degree in some branch of Engineering, Physics or Chemistry and be prepared to work for a Higher Degree.

Particulars and application forms from the Registrar, King's College, London, Strand, W.C.2, whom completed forms must reach by November 20th, 1959. E7719 B

THE UNIVERSITY OF SHEFFIELD

Applications are invited for the GAS PLANT MANUFACTURERS' DEVELOPMENT COUNCIL SCHOLARSHIP, tenable for a Degree Course in Civil, Mechanical or Chemical Engineering or Fuel Technology. Value £350 a year for three years. Closing date 31st January, 1960. Application forms and particulars from the Registrar. E7784 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 F

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

APPLICATIONS are invited for the posts of SENIOR JIG AND TOOL DRAUGHTSMAN, SENIOR MACHINE TOOL DRAUGHTSMAN, and PRODUCTION ENGINEERS, with experience in machining light alloys, for Drawing Office in Southern England.—Write, stating age, details of experience, qualifications and salary required to BOX No. E7748, "The Engineer." A

APPLEBY-FRODINGHAM STEEL COMPANY, SCUNTHORPE, LINCOLNSHIRE, invite applications for posts as SENIOR and JUNIOR DRAUGHTSMEN for general engineering work. Experience in design and detail of plant for iron and steel works would be an advantage. Permanent situations with good prospects for men with initiative and ability. Staff pension scheme is in operation and welfare facilities are available.—Apply, stating age and giving full details of previous experience, and technical qualifications, to the Employment Officer, Appleby-Frodingham Steel Co., Scunthorpe, Lincs. E2611 A

APPLICATIONS ENGINEERS REQUIRED for Technical Department of rapidly growing Lubrication Equipment Company serving heavy, particularly iron and steel, industries. Good prospects for keen engineers prepared to work hard. Layout or D.O. experience or German language an advantage. Location, London, N.18. (Edmonton) —Reply in confidence to Managing Director, Centralube, Ltd., Park Royal Road, London, N.W.10. E2606 A

ASSISTANT CHIEF DRAUGHTSMAN required by expanding Company in Surrey approximately 25 minutes from Waterloo. Successful applicant should be experienced in the design of small mechanisms, &c., be a good disciplinarian, and in view of the specialised nature of the product will be expected to make his career with the Company. Minimum qualification of H.N.C., but men with experience and a sound background who are not so qualified will be considered.—BOX No. E169, "The Engineer." A

ATOMIC ENERGY RESEARCH ESTABLISHMENT, WINFRITH

requires

A PROFESSIONAL ENGINEER

to be responsible for planning minor works and alterations to buildings and to advise on the maintenance of buildings.

Relevant experience, including the preparation of schemes for contract, is essential.

Salary : £1345–£1800 p.a. Housing and superannuation schemes.

Please send a POST CARD for details to : Personnel Branch (W165/25), U.K.A.E.A., A.E.E., Winfrith, Dorchester, Dorset,

not later than 27th November. E7771 A

CHIEF MECHANICAL ENGINEER

TANGYES LIMITED have a vacancy for a Senior Executive to be directly responsible to the Managing Director for design and allied technical matters. This is an appointment calling, not only for high technical qualifications, but also for the ability to co-ordinate engineering matters generally in the organisation and to guide the management in regard to technical policy.

Successful applicant should preferably be in the age group 35-45 and should have had wide experience in mechanical engineering administration. The Company's main products are in the hydraulic and pumping fields and first-hand experience of these would be desirable.

This is a position of wide scope and salary would be commensurate. Contributory Pension Scheme and Free Life Assurance available.

Applications, giving in confidence full details of education, qualifications, past and present employment, to be addressed to the Managing Director, Tangyes Limited, Cornwall Works, Smethwick, Birmingham. E7788 A

CIVIL ENGINEER required for Oil Refinery. He should be a University graduate with professional qualifications and have had administrative as well as practical experience. Experience in Chemical Works or Refineries is not essential, but enthusiasm and drive are requisite qualities for the post. Commencing salary in range £1400–£1600 p.a. Non-contributory Superannuation Scheme and subsidised canteen meals.—Applications, in writing, and stating qualifications and experience, should be made to the Refinery Manager, LOBITOS OILFIELDS, LTD., Ellesmere Port, Cheshire. E7838 A

CIVIL ENGINEERING DRAUGHTSMAN required for Oil Refinery. Must be familiar with surveying and setting out work. Experience of Contractors' work is desirable. Applicants should give, in writing, particulars of their experience and qualifications, upon which the salary will depend. This is a permanent position. Non-contributory Superannuation Scheme and subsidised canteen meals.—Applications should be made to the Refinery Manager, Lobitos Oilfields, Ltd., Ellesmere Port, Cheshire. E7816 A

DESIGN AND DEVELOPMENT ENGINEER

Opportunity for a DESIGN AND DEVELOPMENT ENGINEER to fill permanent position in the London office of a progressive and well-established engineering company.

The man who will fill this position will be up to degree standard, or equivalent, and will be reasonably experienced at heat transfer and fluid flow. A background power plant engineering and some knowledge of steel-works practice would be an advantage.

Applicants should give details of education, qualifications and experience and stage age and salary expected.

BOX No. E7810, "The Engineer." A

DESIGNER DRAUGHTSMAN required for high structures design. Applicants should be over 25 years with experience in steel and/or concrete details. Position can be permanent and is pensionable. Salary offered is competitive.—Write to J. L. Eve Construction Co., Ltd., 24, Worple Road, S.W.19. E2623 A

DETAILER AND DESIGNER with originality and ingenuity required by expanding firm making up-to-date mechanical aids for the Building Industry. Write, giving full details of experience and qualifications.—BOX No. E2613, "The Engineer." A

ENGINEER

Qualified Engineer (B.Sc. or A.M.I.Mech.E. or A.M.I.Struct.E. or H.N.C.) required, preferably with some experience in structural and mechanical engineering. This appointment, which is open to candidates not over 26 years of age, is a permanent one and carries excellent prospects.—Applications should be made in writing (stating age, qualifications and experience to date) to John Young and Co. (Kelvinhaugh), Ltd., 120, Kelvinhaugh Street, Glasgow, C.3. E7774 A

ENGINEER required, to join development laboratory for work on a wide range of industrial instruments. Applicants must hold Degree or H.N.C. in Mechanical Engineering or Physics, and have previous development experience, preferably in the Instrument Industry. Housing available.—Please write, giving full details, to the Chief Design and Development Engineer, K.D.G. Instruments, Ltd., Manor Royal, Crawley, Sussex. E7780 A

ENGINEER, Air Conditioning, able to prepare schemes and negotiate with clients. Progressive position for good man.—Write the Visco Engineering Co., Ltd., Stafford Road, Croydon. E7811 A

ENGINEERS for overseas pipeline contracts required immediately. Young men with experience of design, construction, supervision or planning and estimating in this field are offered excellent opportunities with this company.—Apply in first instance in writing to Collins Submarine Pipelines, Ltd., 18, Park Street, London, W.1. E2556 A

ENGINEERS required for work on design of machine tools, vibration studies, friction and lubrication problems, and research on the machining of metals. Good opportunities in expanding organisation for those with initiative and capability. Location in new building amid pleasant surroundings. Superannuation scheme. Send full details, including age, qualifications, experience and present salary in confidence.—BOX No. E7817, "The Engineer." A

ESTIMATING ENGINEER required for permanent position with World-Wide organisation. Experience in estimating work on petroleum and chemical plant erection. Some knowledge of civil estimating desirable. Good salary.—Send full particulars to McKee Head Wrightson, 16–26, Baltic Street, London, E.C.1. E7789 A

EXPERIENCED DRAUGHTSMAN required, used to conveying and material handling practice, must be capable of both design and detail work. Good salary paid to right applicant.—Write in first instance, stating age, salary required and experience, to Maxim Conveyors (England), Ltd., Crabtree Manorway, Belvedere, Kent. E2600 A

F. W. BERK AND CO., LTD., have a vacancy for a SENIOR PROJECT DRAUGHTSMAN. He will be expected to work with the minimum of direction on modifications to existing plant and the layout of new plant at the Company's works in Canning Road, London, E.15. In many instances this will also involve him in the organisation of site work, when construction begins. We are looking for a man with the combination of experience and initiative needed for such a position. Technical standard O.N.C. minimum. Age 25–40.—Apply Personnel Manager. E7819 A

FIRST-CLASS MACHINE TOOL DESIGNERS preferably with knowledge of Woodworking machine tools, and with experience of pneumatic and hydraulic controls, required for extensive design and development programme. Technical qualifications to, at least, H.N.C. standard.—Apply in writing, stating age and salary required, to Thomas White and Sons, Ltd., Laighpark, Paisley, Scotland. E2618 A

MECHANICAL DESIGN ENGINEER FOR CHEMICAL INDUSTRY

Lankro Chemicals, Ltd., of Eccles, who are manufacturers of chemicals for the plastics, surface active and leather fields, wish to appoint a graduate MECHANICAL ENGINEER, aged 23–29 years, to their design staff. This is a new appointment which has arisen due to continued growth and the Company's policy of carrying out its own design and construction work.

The man appointed will be responsible to the Assistant Chief Engineer (Design and Planning) and important elements of the job will be :

1. Design responsibility for specific projects in the fields of services development, supply and despatch facilities and plant modifications.
2. Mechanical design in relation to vessels, heat exchangers and other equipment.
3. Design of minor structures and foundations.
4. Development of engineering standards and design records.

It is desired to appoint a young man who has completed his engineering apprenticeship and has preferably had some maintenance or construction experience in a Process Industry.

He will assume his responsibilities progressively over a period, during which he will be trained by senior engineers.

An appropriate starting salary will be offered and the position offers good opportunities for progress. A contributory superannuation scheme is in operation.

Applications, in confidence, should be addressed to the Company's Chief Engineer at P.O. Box 1, Eccles, Manchester. E7802 A

MANAGER required for the new STEEL PLANT DIVISION of a large company with several works supplying diverse range of plant and equipment for heavy industries. Duties would include pioneering of the development and selling of plant for new processes in the Steel Industry and general supervision of design and manufacture. Essential qualifications include a good education, a strong technical background in the processes involved in steel-making and extensive actual operating experience. Preferred age range 35 to 50. The post is of considerable scope for a keen man and the conditions offered are commensurate with a senior executive position. Salary in the range of £2500 to £3500 per annum, depending on experience, &c. Replies, which will be treated in strict confidence, should be addressed —BOX No. E2614, "The Engineer." A

FULLY QUALIFIED MECHANICAL ENGINEER required, to take complete charge—including estimating—of varied type contracts up to £10,000 in medium general engineering. Applicant must have a lively and versatile personality and be prepared to cover detailed design work. This is a senior position and is subject to pension. Age 33 to 43 years' approximately. Applications must give details of qualifications, experience and salary requirements.—G. P. BANBURY, LTD., FACTORY LANE, CROYDON. E2624 A

MANCHESTER CORPORATION TRANSPORT DEPARTMENT REQUIRE FULLY QUALIFIED ASSISTANT ENGINEER

Applicants must have passed the Final Examination of the Institution of Mechanical Engineers or its equivalent.

Salary in accordance with the special basic grade of the National Scales, i.e. £785–£1070 per annum. Point of entry according to experience.

Forms of Application may be obtained from the General Manager, 55, Piccadilly, Manchester, 1, and should be returned not later than Friday, November 20th, 1959.

E7829 A

MECHANICAL DESIGNERS for automatic production and assembling machines and mechanical handling of pieceparts ; also food and chemical process plant. Varied projects need ingenuity and enthusiasm. Good salary.—Rhoden Partners, 29, Park Crescent, W.1 (Langham 7488). E7841 A

MECHANICAL ENGINEER required for Oil Refinery. He will be responsible to the Chief Engineer for the maintenance and running of the Plant and Services. He should be a University graduate with a professional qualification and have had practical and administrative experience. Chemical Works or Refinery experience is desirable but not essential, enthusiasm and drive are requisite qualities for the post. Commencing salary in range £1400–£1600 p.a. Non-contributory Superannuation Scheme and subsidised canteen meals.—Applications, in writing, and stating qualifications and experience, should be made to the Refinery Manager, LOBITOS OILFIELDS, LTD., Ellesmere Port, Cheshire. E7837 A

MECHANICAL ENGINEER. Civil Engineers require Plant Engineer to take sole charge of area plant department. The successful candidate should be educated to at least H.N.C. Standard, Conversant with contractor's plant, able to effectively control labour and administer small office and stores. Salary range £750–£850 p.a. according to ability.—Give full details of experience to BOX No. E7835, "The Engineer." A

MECHANICAL ENGINEER. A Midland fan engineering company wish to appoint a qualified mechanical engineer as assistant to the Chief Designer. A knowledge of fan engineering and application is desirable, but not essential, the main qualification is ability to work without supervision. A superannuation scheme is operated by the company, and salary will be based entirely on successful applicant's capabilities. Apply in writing with full details of past experience.—BOX No. E7830, "The Engineer." A

MEDIUM-SIZE FOOD FACTORY in Hull requires services of experienced and well-qualified ENGINEER. A successful applicant would be required to serve as Assistant to the Chief Engineer but should be able to take over full control in his absence. It is essential to have previous experience and successful control of labour ; a practical as well as theoretical knowledge of steam raising and refrigeration is also required and drawing-office experience would be an advantage. Please state details of experience, particularly in the above fields, together with age and salary required.—BOX No. E7671, "The Engineer." A

PILKINGTON BROTHERS LIMITED

have a number of vacancies for MECHANICAL DRAUGHTSMAN DESIGNERS to work on mechanical design problems, under the chief designer in the Central Engineering and Planning Department.

Minimum qualifications H.N.C. Salary according to age and experience. Canteen facilities, five-day week, superannuation scheme, assistance in house purchase.

Application forms can be obtained from Group Staff Department, Pilkington Brothers, Limited, Grove Street, St. Helens.

E7809 A

PRECISION MECHANIC required in the Hotel Industry in West London area. Suitable experience in maintenance and repair of Cine Projectors and ancillary equipment, Power Samas Machines, Comptometers, Tele Tape and Tele Autograph machines, certain more delicate kitchen equipment and various other forms of special equipment. Able to operate and maintain Machine Tools. Address replies to Hotel Engineer.—BOX No. E2621, "The Engineer." A

PUBLIC RELATIONS EXECUTIVE (male) required by expanding Firm of Consultants to handle accounts under the Managing Director. Age about thirty, previous experience of P.R. work, or journalism desirable, scientific or industrial background useful. Good future for hard working, lively and intelligent young man. Salary according to ability and experience.—Write BOX No. E7820, "The Engineer." A

PRODUCTION MANAGER required for old-established medium-sized company in Sheffield manufacturing Precision Engineering Components and Press Work, Hot and Cold Products, Light to Medium Weight, mainly in High Grade Steels. Age under 40, engineering degree desirable. At least 10 years' works experience in similar industry essential with full knowledge of Tooling, Heat Treatment, Production Planning and Control and Rate fixing. Salary and prospects really good for the right man. Applications in strict confidence stating full particulars of qualifications, experience, and salary required.—BOX No. E2617, "The Engineer." A

SITUATIONS VACANT

PROJECT ENGINEER
required for
MECHANICAL HANDLING WEIGHER DIVISION

of old-established and go-ahead company.

Basic qualifications are H.N.C. in mechanical engineering, experience in belt conveyor design, and in commercial contact with customers.

The duties involve visits to customers, the preparation of quotations, negotiation of orders, and piloting of contracts to completion.

There is a contributory pension scheme, with life assurance.

Applications will be considered only from those who possess these qualifications, supported by enthusiasm, and who will work as one of a team.

Write, giving fullest information, including details of present earnings to :

The Commercial Director,
SAML. DENISON AND SON, LTD.,
HUNSLET FOUNDRY,
LEEDS, 10.

E7812 A

SAO PAULO LIGHT S.A.—SERVICOS DE ELETRICIDADE, a Company in Brazil and a Subsidiary of the Canadian corporation, Brazilian Traction, Light and Power Company, Ltd., invite applications from suitably qualified men for the position of SHIFT CHARGE ENGINEER in the Piratininger Power Station. The power station, put into service about five years ago, is situated near Sao Paulo (population over 3,000,000 ; temperate climate, 2200ft. above sea level). The plant comprised initially 2 — 80MW 1800 r.p.m. steam turbo-alternator units, each supplied at 850 p.s.i., 900 deg. Fah. by one 850,000 lb/hr. oil-fired boiler and is now being expanded by the addition of two 125,000 kW reheat units, 1800 p.s.i., 1000 deg. Fah. Applicants should have a sound technical knowledge and wide experience of the operation of modern turbines and boilers, preferably with oil or pulverised-fuel firing ; should also have an aptitude for supervision and the maintenance of harmonious labour relations. Good salary, three years' agreement with first-class passage both ways, with family ; four months paid leave after three years' service.—Written application in the first instance shou'd be made to Mr. Osborne Mitchell, General Manager, CANADIAN-BRAZILIAN SERVICES, LTD., 9/12, Cheapside, London, E.C.2. E7794 A

REQUIRED to commence work beginning December, CONSTRUCTION MANAGER to take charge of erection of a large chemical plant in Pakistan. Good salary and allowances. Post leading to a permanent position on satisfactory completion of the contract. Only those with previous experience of heading up similar major projects, preferably abroad, need apply—Motherwell Bridge Contracting and Trading Company, Limted, 82, Victoria Street, London, S.W.1. E2619 A

RESIDENT ENGINEER required by major contracting company for construction supervision of new Oil Refinery and Chemical Plants. Must be a good administrator and able to assume complete control of site organisations. The successful applicant will deal with clients' jobs of £5,000,000 and over. Salary up to £3000 per annum, according to experience and qualifications. Please write, in confidence, giving full details of past employers and contracts carried out.—BOX No. E7737, "The Engineer." A

STRUCTURAL ENGINEER required to take charge of Consulting Department in a large Architects' Office. Sound structural knowledge and imaginative outlook a necessity.—Apply, stating experience and salary required to BOX No. E7814, "The Engineer." A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WATER TREATMENT DRAUGHTSMEN
DRAUGHTSMEN, senior or junior, with experience in water treatment are required by a rapidly expanding firm who can offer permanent pensionable positions, with a profit sharing bonus which last year amounted to 22 per cent. of salary.—Apply, in writing to William Boby and Co., Rickmansworth, Hertfordshire.

E7644 A

WORKS MANAGER for Leading Firm of Fan Manufacturers in the North of England. A.M.I. Mech.E., or equivalent, good disciplinarian essential, with sound knowledge of sheet metal work and general engineering. Permanent progressive position for man with drive and initiative in administration and production.—Write, giving full particulars of career, age, salaries, &c., in confidence to BOX No. E2618, "The Engineer." A

WORKS MANAGER required for medium-sized heavy engineering works in Glasgow. Must be sound production engineer with experience of controlling and directing labour. State age, experience and salary expected.—BOX No. E2620, "The Engineer." A

YOUNG MAN with mechanical or Chemical engineering training required for Sales and Contracts Department of Boiler and Industrial Plant Division. Permanent position with good prospects for right man. Apply in writing, stating age, experience and qualifications to Labour Officer, Davey, Paxman and Co., Ltd., Colchester. E7813 A

D. NAPIER & SON, LIMITED

London Research Laboratories

are engaged upon a vigorous programme of mechanical research and require a SENIOR ENGINEER to head a team dealing with problems associated with Vibration and Experimental Stress Analysis.

Applicants must be technically qualified and must have had several years' experience in this field. Salary appropriate to qualifications and experience.

Pension scheme and generous holiday allowances. Full details, present salary, etc., should be directed to Dept. C.P.S., Marconi House, 336-7, Strand, London, W.C.2, quoting reference E 795E.

E7776 A

ESTIMATING ENGINEER

An assistant to the Chief Estimator is required by a firm of Marine Engine Builders, who also specialise in the manufacture of heavy pressure vessels and fabricated structures.

Candidates should preferably have experience in this field or alternatively in the preparation of estimates for marine installations.

The post will carry a good salary and eligibility for the Firm's pension fund.

Applicants should preferably possess the Higher National Certificate or equivalent qualifications.

Replies should be sent to The Secretary, John Brown and Co. (Clydebank), Limited, Clydebank, giving details of age, education and experience, also present position and salary.

E7839 A

BOOKS and PUBLICATIONS

To be published shortly

ENCYCLOPEDIC DICTIONARY OF ELECTRONICS AND NUCLEAR ENGINEERING

By Robert I. Sarbacher

A giant new alphabetical reference work containing all the modern terms and definitions, equipments, elements, components and systems. Over 1,400 pages and a million words, form an inexhaustible compilation of the latest scientific information. £8 net. Pre-publication price £6 6s. net.

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E7734 A

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E7777 A

Classified Advts. continued on page 152

SITUATIONS VACANT

SENIOR DRAUGHTSMEN

experienced in bulk mechanical handling or foundry work. Superannuation Scheme. Five-day week. Apply to MARCO CONVEYOR & ENGINEERING COMPANY Ltd., Lynn Road, Leytonstone, London, E.11. LEY 2254.

E7749 A

SITUATIONS VACANT

STRUCTURAL ENGINEERS

COURTAULDS have vacancies for STRUCTURAL ENGINEERS at its Engineering Headquarters in Coventry. Applicants should have good theoretical and practical knowledge, and be capable of designing and detailing steel or concrete structures.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Ltd., 16, St. Martin's-le-Grand, London, E.C.1, quoting reference number B.57.

E7755 A

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APC

ATOMIC POWER CONSTRUCTIONS LIMITED

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The above Company require experienced Senior and Intermediate DRAUGHTSMEN to work on design and layout of Turbine House and Reactor Plant for the Trawsfynydd Nuclear Power Station Project, and also on the preparation of schemes for future home and overseas projects.

Applicants should have had experience in the design or layout of conventional or nuclear generating station plant or alternatively of plant in the chemical or other heavy engineering industry. Technical qualifications to Higher National Standard would be an advantage.

The work involved is of an interesting and varied nature and good opportunities for advancement are available.

Salaries will be in accordance with age and experience. The positions are permanent and pensionable. 5-day week. Applications giving full details of experience, qualifications, &c., should be sent to :

The Personnel Officer (Ref. 93/E),
Atomic Power Constructions, Limited,
28, Theobalds Road, W.C.1.

E7832 A

SITUATIONS VACANT

THE ROVER CO. LTD.

invite applications from qualified Engineers for research duties primarily in connection with design and stressing of sheet metal and other structures in motor vehicles. Applications stating qualifications and experience should be addressed to the Labour Manager, The Rover Co. Ltd., Lode Lane, Solihull, Warwickshire.

E7836 A

The Harland Engineering, Co. Ltd., B.E.P. Works, Alloa, Scotland, has vacancies for two

SENIOR METHODS PLANNING ENGINEERS

one for welding and fabrication, and one for armature winding, notching and electrical core-building. Applicants must be experienced men with thorough knowledge of modern heavy/medium manufacturing techniques in their respective fields, and should preferably be qualified to H.N.C. standard. Positions are permanent and pensionable.—Write in confidence, stating full personal details, to the Works Manager, Department E, B.E.P. Works, Alloa.

E7828 A

G.E.C.

DEVELOPMENT ENGINEERS OR PHYSICISTS

FOR SEMICONDUCTOR POWER RECTIFIERS

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Salary and associated benefits will be commensurate with the importance of the appointment.

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Interviews will be arranged at any time to suit the convenience of applicants. Please write giving full particulars of qualifications and experience to—

THE STAFF MANAGER,
THE GENERAL ELECTRIC COMPANY LIMITED,
WITTON, BIRMINGHAM, 6.

E7815 A

SCIENTISTS AND ENGINEERS

FOR

ATOMIC POWER

The English Electric Company Limited in their Atomic Power Division at Whetstone near Leicester wish to fill positions in the Design and Development Groups concerned with Fuel Elements for Nuclear Power Stations.

The types of Fuel Element include both metallic and ceramic fuels for liquid and gas cooled reactors.

Previous experience in this field would obviously be an advantage but a sound knowledge of one or more of Elastic or Plastic stress Analysis, Heat Transfer, Reactor Design or Metallurgy is probably more useful.

A formal education in the range from D.Phil. to H.N.C. is desirable.

The positions are permanent. Successful candidates will be eligible to join the Company's superannuation scheme after a short qualifying period. Assistance in house purchase will be available.

Interested applicants are invited to write to **Dr. H. S. Arms, Chief Engineer, Atomic Power Division, c/o Dept. C.P.S., Marconi House, 336/7 Strand, W.C.2. quoting reference ER1896F.**

E7822 A

SITUATIONS VACANT

THE APPLIED MECHANICS LABORATORY

ENGLISH ELECTRIC, STAFFORD

In view of the increasing importance of mechanical engineering in the heavy electrical engineering industry there is an increasing need for good engineers on the staff of this Laboratory, which deals with a wide range of mechanical design, development and research problems.

Applications are invited from SENIOR and JUNIOR ENGINEERS and TECHNICAL ASSISTANTS with experience in the following fields :

Stress Analysis

Vibrations

Test Instrumentation and Transducer Development

Engineers with general mechanical engineering experience, especially those who have an aptitude for design are also invited to apply.

It is anticipated that the senior posts will be filled by professionally qualified engineers in the age group 28 to 35. Applicants should feel capable of holding a responsible senior position and controlling the work of others. For some of the posts an aircraft engineering background will certainly be considered.

If you would like to visit Stafford to discuss the work please write, giving full details to Central Personnel Services, Marconi House, 336–7, Strand, London, W.C.2, quoting reference E1295J.

E7775 A

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TOP MEN

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Previous experience in Works Management at any level is desirable. The Company will offer a salary in keeping with the importance they attach to this appointment.

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Management Consultants
109, COLMORE ROW · BIRMINGHAM, 3

E7786 A

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TECHNICAL WRITER required for the preparation of illustrated installation, operation and maintenance instruction manuals and other literature relating to centrifugal pumps, water turbines and electric motors and generators.

The successful applicant will be employed in the Company's Engineering Department where every facility will be provided to guide and assist the execution of the work.

This is a senior permanent appointment and only qualified and experienced persons who possess the imagination for, and skill in, this work should apply.

Applications should be submitted to the Personnel Manager, c/o The Harland Engineering Co., Ltd., "B.E.P." Works, Alloa, Scotland.

E7801 A

SITUATIONS WANTED

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OVERSEAS REPRESENTATION

A Glasgow engineering company is interested in taking up representation abroad on behalf of U.K. manufacturers of proprietary machinery and plant, mainly as employed in chemical and allied industries. The company has wide and influential overseas business connections, particularly in South Africa, the African territories, India, the U.S.A., Canada and the West Indies, and has a long experience in promoting export sales of specialised engineering equipment. The design and sale of the company's own products are carried out by a highly qualified technical and sales staff, members of which travel extensively abroad, maintaining close contact with foreign clients and keeping up to date with business trends and developments. Engineering firms desiring assistance in establishing their products in export markets please apply.—BOX No. E7773, "The Engineer." D

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E7796 L

PATENTS

THE PROPRIETOR of British Patent No. 753,435, entitled "MAGNETIC SEPARATOR FOR USE IN CONNECTION WITH AN ENDLESS CONVEYOR," offers same for Licence or otherwise to ensure practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, 14, E. Jackson Blvd., Chicago 4, Illinois, U.S.A. E7790 H

THE PROPRIETOR of British Patent No. 757469, entitled "TEMPERATURE COMPENSATOR FOR A CLOSED HYDRAULIC SYSTEM" offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E. Jackson Blvd., Chicago 4, Illinois, U.S.A. E7826 H

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Classified Advts. continued on page 154

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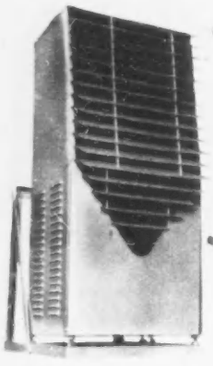

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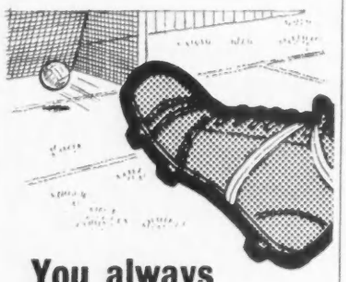

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3	220	3/60	1425/850	2
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1	220/380	3/50	1420	8
1	220	3/50	1420	2

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3	220	3/60	1425/850	4
3	220/380	3/50	1425/850	9
3	220/240/346–380	3/50	1425/850	6
3	280	3/50	1425/850	1
3	210/365	3/50	1425/850	1
3	346	3/50	1425/850	3
3	230/400	3/50	1425/850	2
3	200	2/50	1425/850	1
3	220	2/50	1425/850	1
3	480 DC.	—	1000/1700	1
1	220	3/60	1420	4
1	220/380	3/50	1420	9
1	200/220/346–380	3/50	1420	6
1	346	3/50	1420	2
1	230/400	3/50	1420	1
1	230	3/50	1420	1
1	225/390	3/50	1420	1
1	246–280/230–400	3/50	1420	2
1	200	2/50	1420	1
1	220	2/50	1420	1
1	480 DC.	—	1450	1

CONTROL PANELS

H.P.	Volts	Phase	Cycles	Qty.
3	400/440	3	50	8
3	380	3	50	17
3	220	3	60	6
3	250	3	50	2
3	230	3	50	1
3	480 DC.	—	—	1

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3	346	3	50	3
3	346/380	3	50	3
3	230	3	50	1
3	200	2	50	2
3	400	1	50	1
3	460	1	50	1

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Torque	Volts	Quantity
8 lbs.	220	2
8 lbs.	220/230	2
8 lbs.	230	2
8 lbs.	250	2
8 lbs.	345	1
8 lbs.	346	1
8 lbs.	380	1
8 lbs.	380/420	1
8 lbs.	420	1
8 lbs.	460	2
12 lbs.	200	1
12 lbs.	220	1
12 lbs.	400	1
12 lbs.	400/440	14
12 lbs.	415	1
12 lbs.	380	17
12 lbs.	220	4

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November 17	**Miscellaneous stores,** including :—	M.O.A. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
	Machine tools and woodworking equipment; presses; weighing, gauging and capping machines; webbing; canvas covers and canopies; textiles; cotton; clothing; anti-gas capes; mending wool; thread; steam presses; cloth cutting machines; tubular steel chairs; circular and square canteen tables; electrical and M.T. spares; diesel fuel pumps and injectors; tyres and tubes; nuts; bolts; screws; etc.		
November 25	**Machine tools and miscellaneous stores.**	Technical Stores Depot, **Old Dalby, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
December 3	**Miscellaneous stores.**	M.O.A. Storage Depot, **Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
December 8	**Machine tools and miscellaneous stores.**	M.O.A. Storage Depot, **Byley, Nr. Middlewich, Cheshire.** (Sale at Cheetham Town Hall, Manchester, 8.)	**J. H. NORRIS & SON** (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
December 9-11	**Vehicles, lifting, and earth moving equipment, etc.**	M.O.A. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
December 15	**Miscellaneous stores.**	General Stores Sub-Depot, **Longtown, Nr. Carlisle.** (Sale at County Hall, Carlisle.)	**HARRISON & HETHERINGTON** (Dept. L), Botchergate, Carlisle. (Tel.: 26292.)

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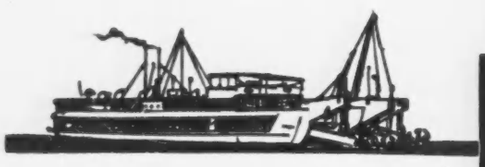

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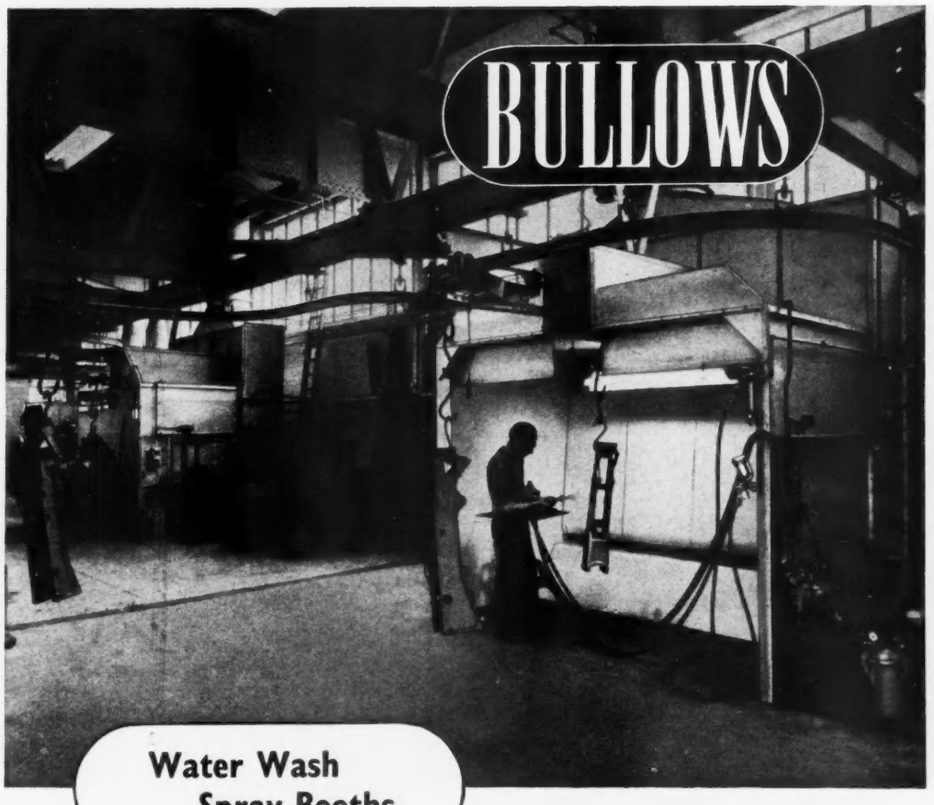

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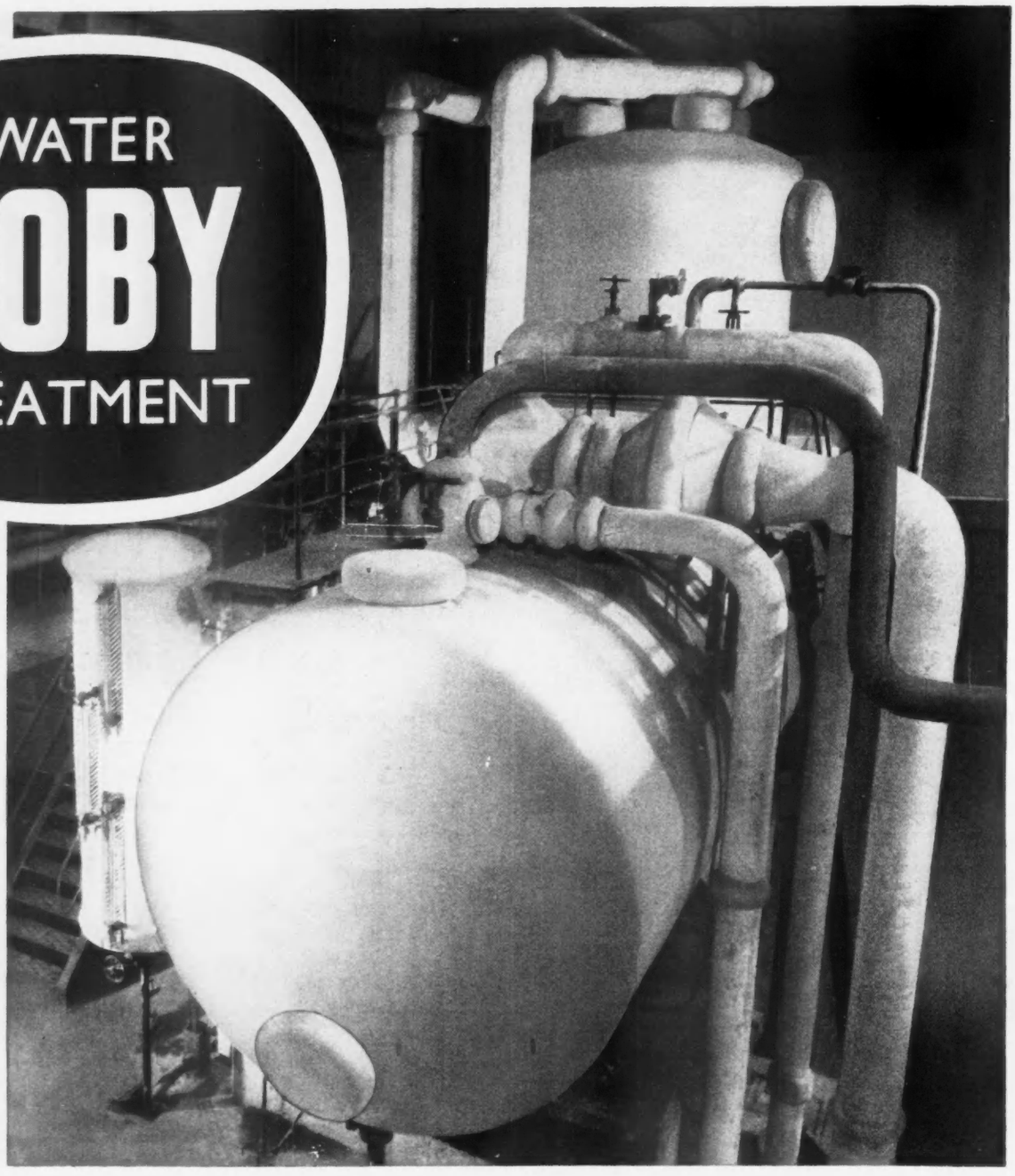

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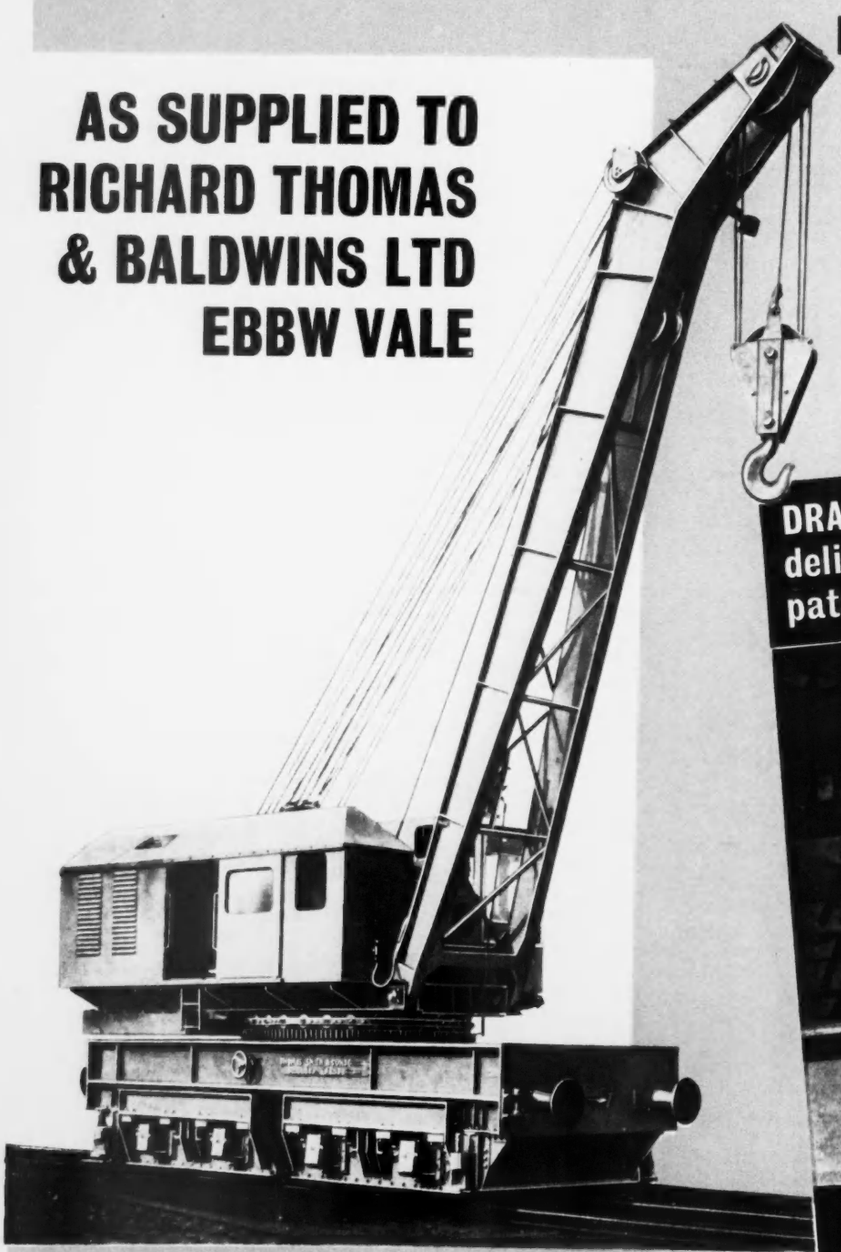

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